MAR 31 1941

ENGINEERING NEWS-RECORD

MARCH 27, 1941

Parker Dam Concrete Cracking

Plate Girder of 271-ft. Span

Sewage Disposal for the Army

A City Hall Within the Budget

sanitation facilities typified by Camp Shelby sewage plant

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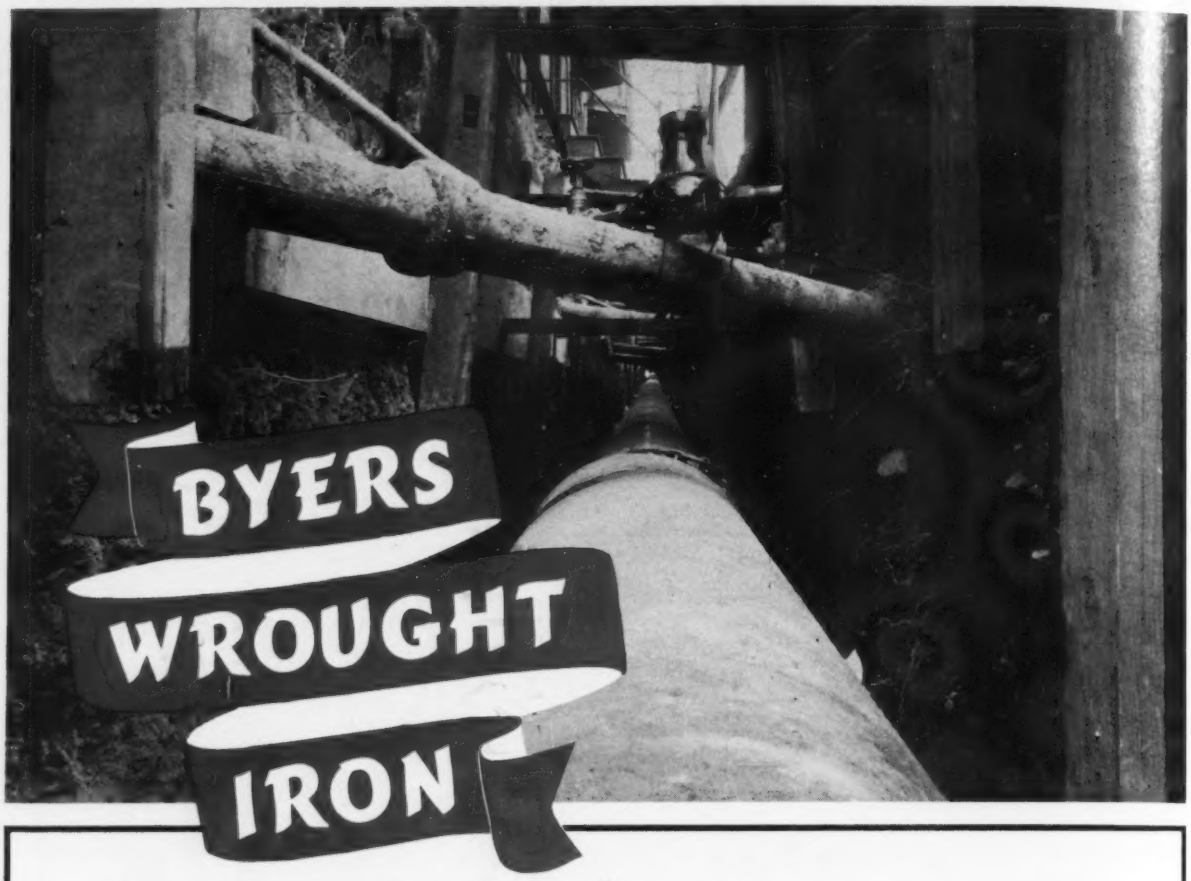
CORROSION COSTS YOU MORE THAN WROUGHT IRON



Combats Corrosion in this 700′ Underground Steam Main

Engineers of the York Steam Heating Company, York, Pa., know the severe service conditions encountered by underground steam mains . . . and they know the way to combat them. For a 700′ run of 15″ O.D. main, specifications were "wrought iron" . . . flat.

Byers Wrought Iron pipe is extensively used for applications like this, because of its proven ability to withstand the severe corrosive conditions that are encountered both from soils and—in conduit installations—from condensed moisture. At Mariemont, a suburb near Cincinnati, Ohio, 3½ miles of Byers Wrought Iron mains are used to distribute steam from a central heating plant. After 14 years in service, the pipe was reported "still in perfect condition." Engineers at Iowa State College, Ames, Iowa, used 14″ Byers Wrought Iron pipe in a concrete box tunnel conduit. A LaPorte, Indiana, utility used wrought iron for underground hot water heating lines. And Cheney Brothers, famous silk manufacturers have 2200′ of ten year old steam returns, part of it housed in tile conduit, of genuine wrought iron.

If you have an installation like this, you don't need to guess or gamble in selecting proper material. Our Engineering Service Department will give you the experiences of other engineers with wrought iron. Ask, also, for a complimentary copy of our bulletin, "Wrought Iron for Piping Systems," which contains helpful information about corrosion and how you can combat it.

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Vol. 126 | MARCH 27, 1941 | No. 13

THIS WEEK

• Traced to adverse alkali-aggregate reaction, the surface cracking on Parker Dam, which has appeared after two years of service, is the subject of intensive study by the Bureau of Reclamation. The problem and related background information is presented.

• The Army has adopted standards for sewage disposal plants being built at military camps, and the design bases established by civilian consultants are reviewed, with accompanying tabular data.

• Designed for public service and built with economy, the Queens Borough Hall, of the City of New York, is the subject of an article of special interest in the building field.

• Setting a new record for plate girder length, the 271-ft. span for the Main Ave. bridge approach in Cleveland provides equally interesting reading on the unusual foundation problems encountered.

THINGS TO COME

• "Chrysler Builds a Tank Arsenal" is a story that covers another phase of defense effort and reviews the design, facilities and construction of this 600,000-sq.ft. factory that will turn out five 25-ton tanks per shift.

• In the field of municipal service the problem of financing refuse collection and disposal is the subject of a review which emphasizes the difference in eastern and western practice.

• At Friant Dam the contractor is using cantilever forms in the pouring of the 5-ft. lifts of concrete, and the design of these forms is a subject of interest to all concerned with mass concrete.

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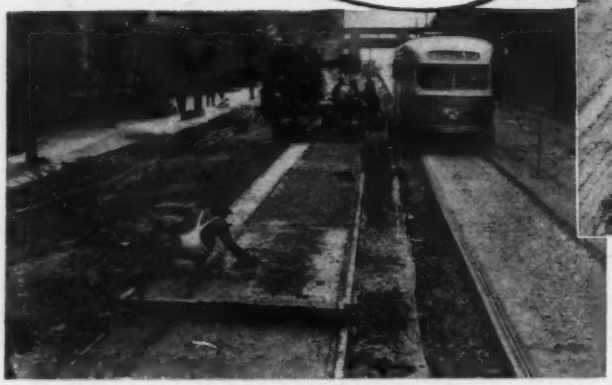
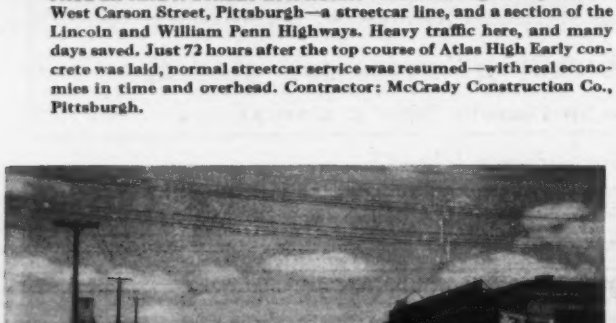
HOW TO KEEP AMERICA ROLLING

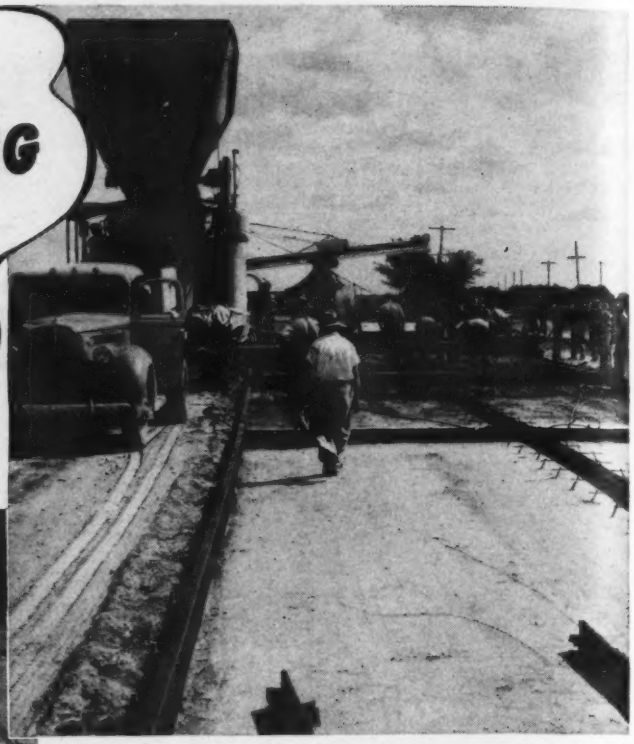
. . . REDUCE TRAFFIC DELAYS
SAVE TIME AND MONEY
ON ROAD BUILDING
WITH ATLAS HIGH-EARLY CEMENT



FACE-LIFTING A STREET IN A HURRY with Atlas High-Early! This is West Carson Street, Pittsburgh—a streetcar line, and a section of the Lincoln and William Penn Highways. Heavy traffic here, and many days saved. Just 72 hours after the top course of Atlas High Early concrete was laid, normal streetcar service was resumed—with real economies in time and overhead. Contractor: McCrady Construction Co., Pittsburgh.



$3 A CUBIC YARD OF CONCRETE SAVED in construction of this Northern Pacific underpass, Bismarck, N. D. This job was done in winter, and the contractor, the Minneapolis Bridge Co., reported a saving of $3 per cu. yd. of concrete in protection and curing costs—thanks to Atlas High-Early cement! This large saving was partly due to the fact that it was necessary to place the concrete in a number of operations, no one placement exceeding 30 cu. yds.



SPEEDING ON AN ILLINOIS ROAD to connect two important state traffic routes with a new stretch of highway. Expensive maintenance costs for an 1100-foot detour were eliminated many days sooner by using Atlas High-Early cement. Traffic was moving again on the highway with a minimum of delay. Contractor: Powers-Thompson Construction Co., Joliet, Ill. Resident Engineer: Terry P. Smith, Illinois State Highway Department.

THE THREE CASES pictured here are typical of the part Atlas High-Early cement plays in keeping wheels rolling on American highways. This cement lops off time required for protection and curing by as much as 60% to 70%—it generally permits earlier stripping and re-use of forms, which often means big savings—and most important of all, it produces serviceable concrete in much less than the usual time.

Specify Atlas High-Early cement on your next job! And send today for your free copy of "Case Histories of Days and Dollars," which gives the whole story of the speed and economy of Atlas High-Early cement. Universal Atlas Cement Co. (United States Steel Corp. Subsidiary), Chrysler Bldg., N. Y. C. *Sales Offices:* New York, Chicago, Philadelphia, Boston, Albany, Pittsburgh, Cleveland, Minneapolis, Duluth, St. Louis, Kansas City, Des Moines, Birmingham, Waco.

ENR-H-31

ATLAS HIGH-EARLY CEMENT

A UNIVERSAL ATLAS PRODUCT

St. Lawrence River agreement submitted to Congress

President Roosevelt makes public an agreement for development of the international section of the St. Lawrence River for power and deep-draft ocean vessels.

An agreement between the United States and Great Britain providing for the construction of an enlarged ship canal in the international section of the St. Lawrence River, development of power at dams built for that canal, remedial works to redistribute the flow of water over the falls at Niagara and for increased diversion around the falls at some later date if found practicable without injury to the scenic effects at the falls, was submitted to Congress on March 21 by President Roosevelt with the statement that legislation designed to make the agreement effective would be introduced into Congress in the near future. The agreement was signed in Ottawa on March 19; it becomes effective when ratified by Congress and the Canadian Parliament.

Proposed construction

An annex to the agreement describes briefly the physical works called for in the International Rapids. There is to be a single-stage development with a control dam near Iroquois Point (the head of the rapids) to regulate the flow from Lake Ontario, a dam in the Long Sault at the head of Barnhart Island (about 10 miles above Cornwall, Ont.), one power house on each side of the international boundary at the foot of Barnhart Island, a side canal and locks on the New York side for navigation, and dikes on both sides of the border to restrict the flooded areas. The locks are to be 30 ft. deep over the sills and the channels will be 27 ft. deep. Also included is channel enlargement at several points, relocation of highways and railways and flooded towns.

The engineers estimate that the work can be substantially completed four years after active work is initiated.

The Great Lakes-St. Lawrence Commission is to be set up with equal representation for Canada and the United States to prepare plans, let contracts and supervise all work except installation of machinery for development of power and work required for rehabilitation on the Canadian side. That work will be undertaken by Canada along with the enlargement of Canadian waterways. Installation of power machinery on either side of the border is not covered by the agreement.

Lake level preservation

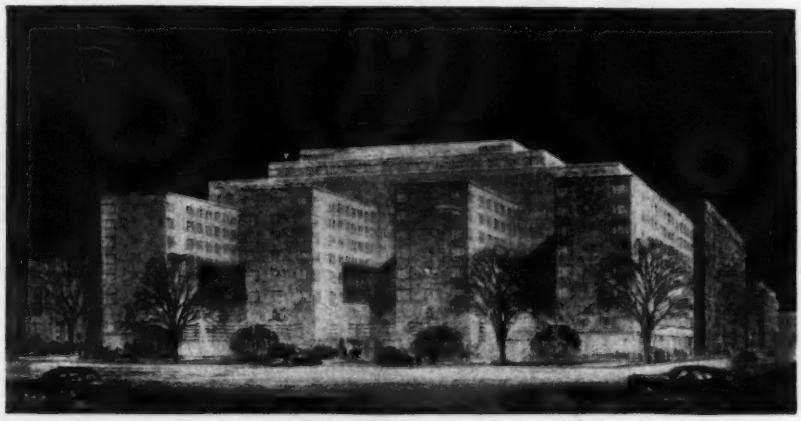
Each country agrees to keep records of the amount of all waters diverted from the Great Lakes, and if either increases any diversion over that authorized as of Jan. 1, 1940, that increase must be subject to arbitration if compensation cannot be agreed to by mutual consent. Any diversions into the Great Lakes are to be credited to the country making the diversion.

The commission is instructed to make recommendations as to compensating works needed to regulate channel depths.

Flow control at Niagara

Plans for works above Niagara Falls to distribute the flow more uniformly over both falls and to check the rate of erosion are to be prepared by the commission, and the two governments agree to provide for their construction by an exchange of notes. Temporary increases in diversions from above the falls to facilitate construction are authorized, and on completion of the works above the falls an increase of 5,000 cfs. on each side of the falls is authorized. Further, the two governments are instructed to make a complete study to determine the "most efficient utilization and equitable apportionment" of the waters that can be used for power purposes without injury to the scenic effect.

The total cost of the proposed works is placed at $266,170,000, which is divided among works solely for navigation, $38,578,000; works primarily for power, $98,804,000; works common to power and navigation, $130,788,000.



New $8,500,000 Hotel Statler for Washington

The Hotel Statler Co. will soon begin the erection of an $8,500,000 hostelry in the Nation's Capital as shown by architects drawing above. The structure will contain 1,000 rooms and will be the eighth in the Statler group. Construction will be steel frame, concrete slab floors and exterior walls of stone. John W. Harris, Inc., of Delaware is general contractor, Holabird & Root, Chicago, architects, A. R. Clas, as associate architect.

Huge tent to protect Mud Mountain Dam core

To protect the central, earthfill core of the $8,000,000 Mud Mountain Dam, from rain and snow, a huge tent has been suspended between walls of the White River canyon near Seattle, Wash.

The great canvas, weighing approximately 35,000 lb., was fabricated by the Seattle Tent & Awning Co., and was laid in sections on the canyon floor, laced and lifted manually in a single piece by a crew of more than 30 men, working with 22 hand hoists. The tent is suspended by six main steel cables doubled across the canyon and fastened to concrete anchors tunneled into the canyon walls at elevation 1,120. Distance between the anchorages varies from 450 to 570 ft. because of the variable width of the canyon. Suspended from each of these main cables are one central 4-sheave block and six intermediate 3-sheave blocks, through which steel cables fall vertically to 3- and 2-sheave blocks at about elevation 1,010. Between each lower sheave block and the tent—the ridge of which parallels the canyon walls—runs a wire rope with eyes at elevation 1,000. To the eyes are attached horizontal wire ropes anchored to steel eye bolts in the canyon walls to keep the suspension cable vertical and the canvas taut. The main suspension cable is fastened to the ridge while the intermediate cables are fastened to six points between the eaves and the ridge.

Eaves of the tent are fastened to the canyon walls, just a few feet away, by hundreds of manilla ropes looped through eye bolts grouted into the rock walls. Just below the eaves are 4-ft. gutters, designed to carry away run-off from the eaves and down the canyon walls.

The main cables will remain at their position during the length of the job, but as the dam grows, the tent eaves will be raised from elevation 950 to 1,000 and later to 1,050.

Work was started last week on placing of the earthfill and will proceed on a 24-hr. a day basis to bring the dam up to the top of the spillway by December, when the river reaches flood stage.

Contract for the dam, which is being built by U. S. Engineers as a flood control project, is held by the Guy F. Atkinson Co. of San Francisco.

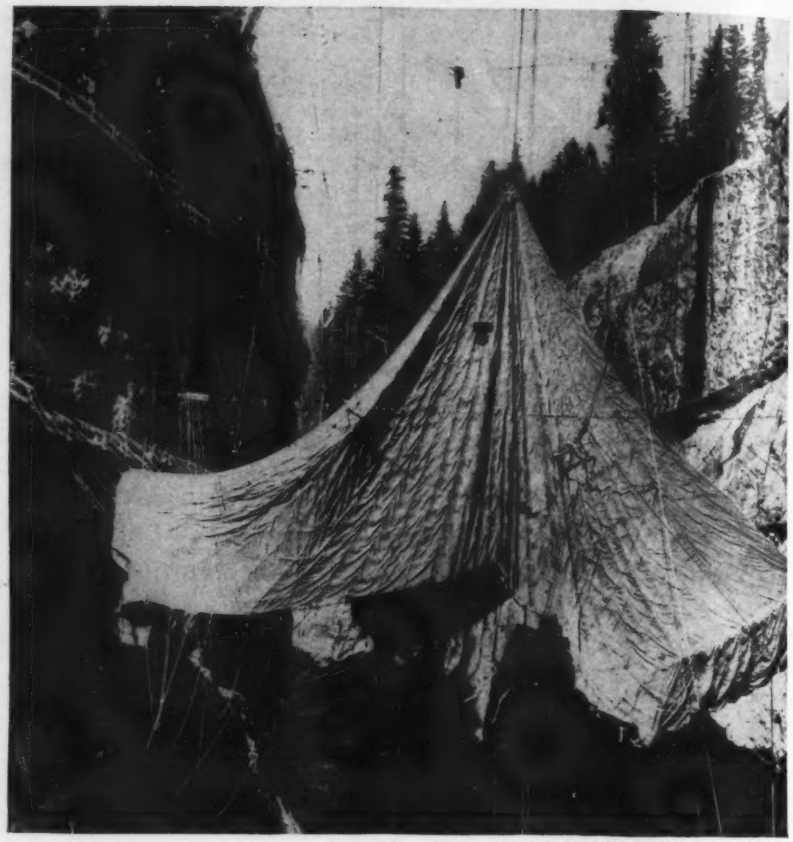


Photo by International News

Measuring approximately 328 x 196-ft. the second largest tent known rises above the White River Canyon of Washington to protect the earthfilled core of Mud Mountain Dam.

• • •

Evansville Bridge freed as bonds are retired

The first instance in which a toll bridge financed by revenue bonds has been made toll-free was celebrated on March 20, 1941, when tolls were removed from the Ohio River crossing between Evansville, Ind., and Henderson, Ky. Revenue bond financing was introduced in this country on the Ohio River bridge at Louisville in 1928, and since that time has been widely used. Most projects so financed have included a provision for making them toll-free after the bonds have been amortized, and the Evansville bridge provides the first successful conclusion of such a plan.

Retirement of the Evansville bridge bonds comes 8 years and 8 months after toll collection began, which is about two years less than was originally estimated as necessary. One reason for the early retirement of the bonds was that only half the total cost was covered by them, the remainder of the cost being paid for by federal-aid funds. Another reason was that the original 4½ percent bonds were later refunded at a 3½ percent rate. The toll rate was 30c for passenger cars, with higher rates for trucks, and the total issue of bonds $2,285,000.

The Evansville bridge project consists of a 3-lane structure, nearly a mile in length, and about 6 miles of approach highway. The main bridge crossing, consisting of a 4-span through cantilever structure some 2,500 ft. long and about 3,000 ft. of plate girder deck truss and I-beam approach spans, was designed and its construction supervised by the firm of Modjeski and Masters, Harrisburg, Pa. All administrative work on the project was handled by the Indiana State Highway Department, which also designed and supervised the construction of the approach highways.

• • •

AFL painters to freeze wages on defense work

First national labor agreement prohibiting strikes and lockouts on defense jobs since the A. F. of L. laid down its no-strike policy for defense work last January was signed the past week by A. F. of L.'s painting and decorating contractors of America and the Brotherhood of Painters, Decorators and Paperhangers.

The union, with 125,000 members throughout the country, pledged that it would not raise wages after a defense project had been started; that it would not "jack up" dues and initiation fees and that it would supply qualified painters for all defense jobs even if it had to move them from other states.

Tacoma Narrows Bridge dismantling recommended by engineers

Report of owner's consultants says towers and cables of the wind-wrecked span are damaged beyond repair

An accurate explanation of the cause of the Tacoma Narrows bridge collapse must await a complete dismantling of the structure, according to the report of the board of engineers retained by the Washington Toll Bridge Authority to investigate the collapse. The report of the board, which was composed of L. J. Sverdrup, St. Louis, Russell G. Cone, San Francisco, and Francis Donaldson, New York, was released last week by Governor Arthur B. Langlie of Washington.

The engineers found only the piers salvageable, recommending dismantling and removal of the main cables, razing the two main towers, removing the tops of the main piers for inspection, removing the major part of the concrete anchorages to which the main cables were attached ashore and dismantling the upper section of tower 3, which supports the west side approach to the main span.

The report said it would cost $635,952 to dismantle the useless parts of the bridge and that reconstruction would require $3,818,826, based on the present material and labor market. The decision to dismantle is at variance with the claims of the insurance companies, also based on engineering advice, that the towers and cables can be re-used (*ENR*, March 13, 1941, p. 381).

Cable wires broken and displaced

"During the distortions accompanying the collapse", the Authority's report said, "the cables were violently tossed through space with vertical movements over 100 deg. in amplitude, accompanied by large sidewise and torsional action. Such large distortions must necessarily disturb the accurate adjustment of the individual wires of the cable by displacing them from their proper position, and also introduce the likelihood of broken wires within the cables. Wires within the cable, broken or overstressed during that distortion, cannot be discovered until all wrapping and cable bands have been removed and the cable explored by opening with wooden wedges.

"In addition there was complete breakage of some 600 wires in the north cable and damage to wires at other points where the wrapping wire had been abraded. There is also a probable loss of strength of the individual wires at fixed points."

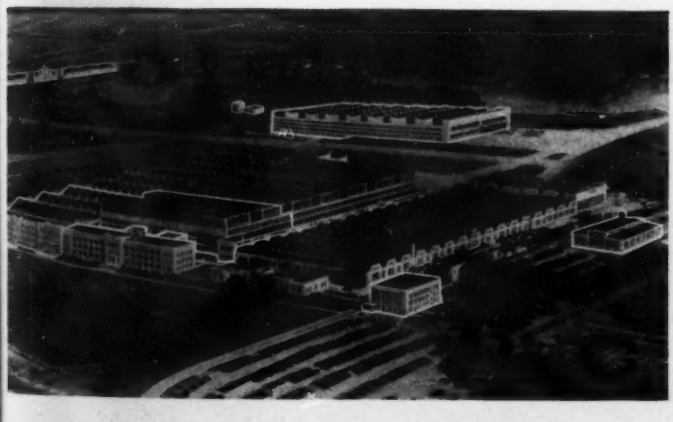
The engineers recommend that the cables be severed, strand by strand, and dropped into Puget Sound. Good sections of the cable could not be re-used since the wrappings must be unwound, destroying the galvanizing, the report said.

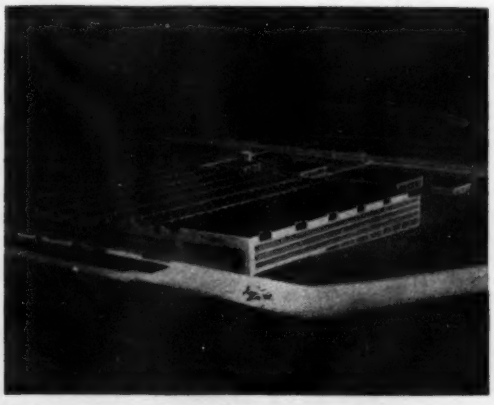
Towers permanently distorted

"Inspection of the two main towers", the report stated, "clearly shows that these structures have been severely twisted and bent generally, resulting in stresses beyond the elastic limit of the metal, with accompanying buckling and permanent distortion. The base tier, the top tier, the top strut and all the intermediate cells on the land or compression side show evidence of overstress varying from complete failure to noticeable buckling. On the tension side, all tension joints are open. This estimate therefore considers that all these members will have to be discarded, but that there is a possibility of re-using members of the central section and three lower struts, if inspection after dismantling shows that these pieces would meet the requirements of the original specifications." Steel in the towers would be lowered, piece by piece, to barges, to be hauled away for salvage. Heavy movement of the towers extended to the anchorage grillage in the main piers, necessitating its removal also, the engineers found.

"Notwithstanding the care used to remove rivets and dismantle the floor steel", the report continued, "it is now determined that the webs of the floorbeams

(*Continued on p. 39*)





Vast plant expansion to meet U. S. and British demands for bombers

Working at top speed, engineers and contractors for the Glenn L. Martin Co., aircraft builders, Baltimore, Md., are pushing construction on new projects that will shortly give the Martin Co. a total of 5,200,000 sq.ft. of floor space for the manufacture of bombers.

Large-scale additions to the main plant, at Middle River, Md., are shown outlined in the illustration at left; these additions having already been completed or now under construction. An entirely new factory being built 1¼ mi. away from the main plant (at right) is already 40 percent complete. General plant expansion operations were begun on Sept. 4, 1940.

Besides the vast expansion program being carried on at the Middle River site, construction will start immediately on a third plant at Omaha, Neb. The Omaha plant will generally duplicate plant No. 2 (illustrated at right above) and will include an airport and service buildings, and will have an area of approximately 1,180,000 sq.ft.

Construction at Middle River is being handled by Consolidated Engineering Co., Baltimore, Md. Contract has been let for the Omaha, Neb. plant to Peter Kiewit Sons Company, Wood Bros. Construction Co., both of Omaha, and to G. W. Condon Co., Lincoln, Neb. Costs of the Middle River plant expansion program is estimated at $24,000,000, while cost of the Omaha plant is $8,078,000.

Radford plant opens three months ahead of schedule

The Radford Ordnance Works, first of the U. S. Government's defense plants to come into production, was officially dedicated Mar. 13, at Radford, Va., when one of three powder lines was completed three months ahead of original schedule.

At the dedicatory ceremonies, John J. Watts, senior member of the firm of Mason & Hangar, contractors for the project, paid high tribute to the fine cooperation by the vast army of 23,000 workers, engineers, government officials and others, who made possible the opening of this plant three months ahead of original schedule.

The projected plant covering 4,400 acres will have three powder lines, each with a production capacity of 100,000 lb. of powder daily, and 616 buildings, of which 450 will be for manufacturing purposes. The total cost of construction and equipment is estimated in excess of $40,000,000.

In size, location and construction, careful study has been given to the possibility of explosions, and each building has been so designed and placed as to minimize this danger, both to men and property. The power plant (shown at left in the above illustration) dominates in size the first group of buildings completed, and is of steel frame construction with brick closure walls. The majority of manufacturing buildings are two stories—ground floor and upper story, with concrete foundations, and concrete partition walls on the ground floor. Upper story is frame construction with asbestos-cement siding and roof, with lighter concrete partitions between working units.

The entire project was constructed under the jurisdiction of the Quartermaster Corps and Ordnance Department of the U. S. Government. The Hercules Powder Co., Wilmington, Del., who will operate the plant for the government, designed the plant, and construction is being carried out by Mason & Hangar.

Photos by Acme

Where explosions are most likely to occur every precaution has been taken to minimize such danger to workers. The finishing press building shown here is typical, with outside chutes for quick exit. Construction consists of concrete foundation and end walls, heavy concrete partitions divide the building into ten units on the ground floor and lighter concrete partitions are used on the second floor. The upper story is of frame construction.

Army gets more money for bases and warehouses

Lumber to be bought now and held to check a price rise when the demand increases

The fifth supplemental defense appropriation, passed by the Congress this week, contains some $227,325,000 for new construction. Biggest items are funds for construction of Army garrisons at the new Atlantic bases and money for a program of warehouse construction for storage of army equipment and supplies.

Also included is $7,500,000 with which the army intends to buy a lumber stockpile of 250,000,000 b.ft. which will be available at reasonable prices when the next big program of temporary construction comes along, a cut from the 500,000,000 b.ft. asked. Testifying on this item, General Somervell said that the price of No. 2 common rose from about $30 a thousand last spring to a high of $42 to $46 last fall, when the centralized purchasing plan went into effect. The price has since declined to about $33, but the Quartermaster Corps has found that it can now buy lumber for future delivery at $24 to $28.

Warehouse construction

For construction of storage facilities, $112,000,000 is appropriated. Some $82,000,000 has already been appropriated for the same purpose in this fiscal year, and the full program contemplated will cost about $283,000,000. The timing of the money is based on expected deliveries of goods to be stored. Of the present money about $16,500,000 is for storage of quartermaster supplies; some $10,350,000 for truck garages and repair shops; and most of the remainder is for ammunition storage and storage for airplane engines and the like.

Atlantic bases

The bill gives the Corps of Engineers $94,000,000 for construction of garrisons at the Atlantic bases. From the President's emergency fund, $25,000,000 has already been made available for this purpose, and the entire army program is expected to cost $200,000,000. This is independent of the Navy work. The contracts under which this money will be spent have already been let except at Jamaica and Bahamas Islands.

Other construction projects in the bill include $4,500,000 for two intermediate landing fields on the air route from Seattle to Alaska; relocation of the Alaska R.R. at a cost of $5,300,000; a $14,575,000 Marine Corps training area in North Carolina; and a $2,500,000 Naval ammunition depot at San Diego.

The bill also provides for $549,000,000 worth of new munitions plants, of which part will be for construction.

Non-defense work holds attention of Connecticut civil engineers

Flood-control, model studies, parkways and tolls hold attention at annual meeting of society at New Haven

With about 300 of a total membership of nearly 1,000 registered, the Connecticut Society of Civil Engineers in its 57th annual meeting at New Haven, Mar. 18-19, placed major emphasis on the regular public works projects of that state. Defense construction gained little attention.

In his paper "Parkway and Bridge Tolls," which was read by John F. Willis, Connecticut highway department, Wm. G. Grove, designing engineer with the Connecticut department, stated "There are many cases where tolls would not be the most satisfactory solution of the financial problem. On the other hand, where it is practically impossible or very difficult to finance a much needed public improvement, the toll proponents offer a solution of the problem which is based on a fundamental axiom, viz: The American motoring public is willing to pay for super-service. . . ."

Later in telling of Connecticut's Merritt Parkway, he pointed out, "Since tolls were placed, about 11,000,000 cars have passed the two toll stations, so that the highway department has about $1,000,000 more than we had in June, 1939, while an alternate free route is only 5 miles away. And that is our answer to our critics, namely, that John Q. Public is willing to pay for super-service, which provides: first, safety, and secondly, a saving of time through the absence of red lights over a distance of 35 miles."

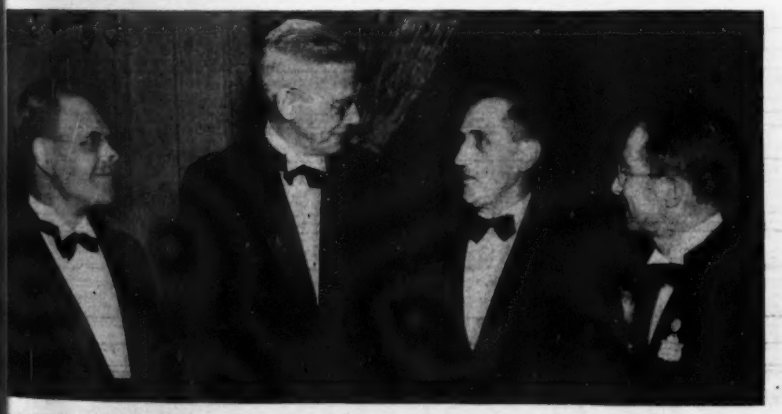
When 200 gathered for the annual banquet Tuesday night, Wm. J. Cox, Connecticut highway commissioner, told of "Economic Features of the Hartford and New London Bridge." Mr. Cox outlined the many studies that determined where the two structures now under construction should be built. The Hartford crossing, which will have one girder span of 300 ft., the longest ever built in this country, will be opened to traffic in the summer of 1942. The New London crossing will be used in the late months of 1942.

Charles W. Cooke, division engineer of the city engineer's department at Hartford, described Hartford's present flood-control program. Mr. Cooke stressed how the program could not be treated from the flood-control angle alone, but had to include extensive studies of highway relocation, park beautification, land values and coordination with the U. S. Engineers and other organizations carrying out improvements at Hartford.

In his paper, "Hydraulic Model Testing," Arthur N. Vanderlip, assistant professor of civil engineering at the University of Connecticut, described the progress in model tests since 1925 and stressed the need for tests on the prototype when actually built to check model results.

Other speakers included: Bryant Burkhard, Yale Bureau of Street Traffic Research, telling of the modern parkways of Connecticut and New York; Samuel P. Senior, Bridgeport Hydraulic Co., describing the use of a concrete with a slump of from ¼ to ½ an inch on Saugatuck Dam; Stanley Crute, chief construction civil engineer with the Connecticut department of public works, discussing the $25,000,000 public buildings program recently completed by the state of Connecticut; and Warren J. Scott, director of the bureau of sanitary engineering with the Connecticut Health Department, telling of "Modern Trends in sewage treatment in Connecticut."

Those receiving life membership certificates at the banquet were: Clarence M. Blair, New Haven; Frank M. Travis, Torrington; and Wm. R. Dunham, Jr., Jamestown, R. I. Awards for outstanding papers were given to: Arthur G. Beaulieu, Francis T. McNamara, and Edward J. Rockefeller, of New Haven.



New officers of Connecticut civil engineers

When members of the Connecticut Society of Civil Engineers held their 57th annual meeting at New Haven last week, these four men were placed in charge for the coming year. They are left to right: H. Jackson Tippet, New Haven, reelected secretary-treasurer; Leslie G. Sumner, West Hartford, second vice-president; W. Vincent Barry, New Haven, president; and Robert S. Rose, Hamden, first vice-president. Frederick P. Stabell, South Norwalk, is the retiring president. Next year's annual meeting will be at Hartford.

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Plan to curb sewage peril in Detroit area

The Michigan State Stream Control Commission has approved a $4,700,000 master plan for gathering uncontrollable sewage from southern Oakland and Macomb counties and passing it into the Detroit municipal sewage-disposal plant.

The plan is aimed at solving the sanitation problem in areas being overrun with defense-industry workers.

The commission recommends that the plan be carried out by the creation of county sanitary districts working through WPA. Special federal funds will be requested to take care of 40 per cent of the normal WPA sponsor's contribution, reducing the cost to the local area between 12½ and 15 per cent of the total.

The master plan proposes leading all untreated sewage from the area into a new 60-in. tunnel sewer where it will be metered and pumped into the Detroit sewer system.

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Tacoma Narrows Bridge dismantling recommended

(*Continued from page* 37)

have been cracked and pulled out of shape so that reaming and oversize rivets would be required. All suspended structure steel is therefore considered to have only scrap value. The steel of the west approach, being of similar construction, is also considered only as scrap. All stiffening girders were greatly overstressed and have been considered as scrap."

The board reported that tie-down cables, installed after the bridge developed a rippling motion soon after it opened, "did not cause eventual failure of the bridge".

Hydro-electric power for Canadian Northwest

First hydro-electric power in the Canadian Northwest has been turned on at Yellow Knife, on Prosperous Lake, supplying power for the Consolidated Negus and Rycon gold mines. Previously, power for gold mining operations in this territory was supplied by diesel units.

Construction of the power project included a timber-crib rockfill dam 760 ft. long and 16 ft. high; a rock tunnel 800 ft. in length, a wooden penstock with a 90-ft. surge tower (as shown above); a frame power house and sub-station, and a 33,000 volt steel tower transmission line for the delivery of 4,200 hp. for the initial development. The plant was erected at a cost of $600,000.

H. S. Tiedge was engineer for the Consolidated Mining & Smelting Co. of Canada Ltd., owners of the property. The contractor was Bennett and White Construction Co., Ltd., of Calgary, Alberta.

Floodway work started in Lower Rio Grande valley

Construction has been started on an additional 4 mi. floodway project in the Lower Rio Grande valley by the International Boundary Commission. The project consists of reconstructing and reconditioning all levees on the Mercedes section of the valley floodway in the vicinity of San Benito, Tex., and includes approximately 1,125,000 cu.yd. of compact embankment, 55,000 cu.yd. common embankment and approximately 1,300 acres of clearing and grubbing.

The Hughes Construction Co. of Hillhouse, Miss., holds the contract and J. L. Lytel is project engineer for the International Boundary Commission at San Benito.

JOBS OF THE WEEK

HOUSING, Brooklyn, N. Y.
Corbetta Construction Co., New York, N. Y., was lowest bidder when proposals were opened Mar. 18 for constructing foundations, and appurtenances at Fort Green Housing Project, at $1,105,000. New York City Housing Authority took bids. Total cost of the project which will be the largest public housing development yet attempted will be $20,404,000.

MAGNESIUM CHEMICAL PLANT, Freeport, Tex.
Austin Co., Houston, Tex., has been awarded contract for constructing magnesium chemical plant expansion, by Dow Chemical Co., who will operate. Estimated cost is $8,007,407.

ORDNANCE EQUIPMENT PLANT, Center Line, Mich.
Hudson Motor Car Co., Detroit, Mich., has been awarded contract for constructing and equipping plant for the manufacture of ordnance equipment by Navy Department. Estimated cost $20,000,000. Plant will consist of a number of buildings instead of the one huge structure that characterizes many of the other new defense factories.

DRYDOCK, Galveston, Tex.
W. Horace Williams, New Orleans, La., will build naval dry dock on Pelican Island, Galveston Co. for Todd-Galveston Dry Docks, Inc. Total estimated cost $2,800,000. Navy Department allotted funds for construction.

NAVAL ORDNANCE PLANT, Indianapolis, Ind.
Austin Company has been awarded contract for the construction of Naval Ordnance plant by Lukas Harold Corp., New York. Estimated cost $4,000,000. Total estimated cost $6,000,000. Navy Department awarded contract to Lukas Harold Corp.

HOUSING PROJECT, Charleston, S. C.
J. A. Jones Construction Co., Charlotte, N. C., was awarded contract for constructing housing project at $1,400,000 by Housing Authority of City of Charleston. Halsey & Cummings, D. D. Ellington, and Harold Tatum, are architects.

ALUMINUM PLANT, Longview, Wash.
The Austin Co., Cleveland, O., awarded contract for variety of buildings for new aluminum plant by Reynolds Metal Co. Cost is estimated at $1,000,000. J. E. Sirrine Co., Greenville, S. C., is engineer.

AIRPLANE PLANT, Melrose Park, Ill.
Thorgersen & Ericksen Co., Chicago, Ill., has been awarded contract to build 1,000,000 sq.ft. plant for manufacturing airplane engines by Buick Motor Division of General Motors Corp., Detroit. Estimated cost $31,000,000 including equipment. Albert Kahn & Associates, Detroit, are engineers and architects.

LABORATORIES, Princeton, N. J.
H. K. Ferguson Co., New York, N. Y., has been awarded contract for the construction of radio research laboratories, office and auditorium by Radio Corporation of America, New York. Estimated cost is $1,000,000.

HOUSING, Savanna, Ill.
Coath & Goss, Inc., Chicago, Ill., has been awarded contract for the construction of 200 unit housing project at Savanna Ordnance Depot, by Public Buildings Administration, Washington, D. C. $625,700.

HOUSING, Grand Prairie, Tex.
Central Construction Co., Dallas, Tex., received contract for the construction of three hundred temporary dwellings, to cost $712,500. Public Buildings Administration, Washington, D. C., awarded contract for project to house employees at new North American Aviation plant.

DRAWBRIDGE, Panama Canal.
Pittsburgh Des Moines Steel Co., Pittsburgh, has been awarded contract constructing drawbridge over Miraflores Lock, at a cost of $1,078,840. The Panama Canal Commission awarded contract.

RECEPTION CENTER, Camp Shelby, Miss.
J. A. Jones Construction Co., Charlotte, N. C., awarded supplemental contract for construction of reception center, additional housing and hospital facilities by Construction Quartermaster, Washington, D. C. Additional cost $1,431,853. Lockwood, Greene Engineers, Inc., New York, are engineers.

MINE HANDLING and WATERFRONT FACILITIES, Mare Island, Calif.
Cahill Brothers and B. C. Gerwick, Inc., San Francisco, will construct mine handling and waterfront facilities at Naval Ammunition Depot at $1,250,000. Bureau of Yards & Docks, Navy Department, Washington, D. C., is owner.

NOTE—Additional bidding and contract news on over 800 projects large and small appear in the Construction News section beginning on page 119.

OBITUARY

THOMAS JONES, 56, superintendent of waterworks, Strasburg, Ohio, was accidentally killed Mar. 17. He had been in charge of the waterworks since 1936.

WILLIAM EMERY, engineer associated with Day & Zimmerman, Inc., died Mar. 12 at Harrisburg, Pa. He was 49.

CHARLES P. MORGAN, consulting engineer, 64, died Mar. 8 at Los Angeles, Cal. He was associated with the Southern California Telephone Co.

CORNELIUS E. BARNES, SR., 79, retired engineer, died Mar. 11, at East Orange, N. J. He was formerly with Standard Oil Co. for 26 years.

CHARLES I. RITCHIE, 49, plant surveyor for Dyer Engineers, Inc., died Mar. 13 at Cleveland, Ohio.

LLOYD E. SPITTLE, 59, a retired structural engineer, died Mar. 13 at Cleveland, Ohio. He was formerly with the H. K. Ferguson Co., general contractors.

WILLIAM J. PEACHY, engineer, died Mar. 13 at Cleveland, Ohio. He was associated with the Baltimore & Ohio Railroad for 40 years.

JEROME J. DAY, 64, mining engineer, died Mar. 9 at Phoenix, Ariz.

GEORGE HALL HAZLEHURST, 54, chief engineer and director of the bureau of sanitation, Alabama Health Department, died Mar. 8 at Montgomery, Ala. He had been with the Alabama state department of health since 1917.

FRANK M. BEAUDREAU, 58, federal construction engineer, died Mar. 9 at Tacoma, Wash. He had been with the Government for 17 years.

THOMPSON R. RICHARDSON, 43, U. S. Engineer, died recently while working on the Brevoort levee project near Anderson, Ind.

C. C. VAN ARSDOL, 88, civil engineer, died Feb. 24 at Lewiston, Idaho. Mr. Van Arsdol was one of the leading highway and railway engineers in the West. He was one of three to be the first to receive an engineering degree from the University of Iowa, in 1876.

WILLIAM P. SHINE, 69, for many years one of the best known structural steel contractors in New England, died at his home in Arlington, Mass., Mar. 17. He was a former president of the Boston Structural Steel Co., Cambridge.

T. G. GLADNEY, engineer with the Mississippi Highway Department, died Mar. 1 at Jackson, Miss. He was one time dean of University of Mississippi school of engineering. He was a member of the Mississippi State Board of Engineers.

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Stone & Webster names new board chairman

Edwin S. Webster, co-founder of Stone & Webster, Inc., has been elected chairman of the board of directors, to fill the place left vacant by the late Charles A. Stone. The office of vice-chairman, formerly held by Mr. Webster, has been eliminated.

Marshall Ford Dam changed to Mansfield

The board of directors of the Lower Colorado River Authority has announced that the name of the $26,000,000 federally financed Marshall Ford Dam, now under construction on the Colorado River in Tex., has been changed to Mansfield Dam. The new name is in honor of Representative J. J. Mansfield of Texas.

Construction of the dam, 260 ft. high and the largest of a series of four on the Colorado River near Austin, was begun in 1935 with a $5,000,000 allocation of relief funds. Later legislation drafted by Representative Mansfield, as chairman of the House Rivers and Harbors Committee, authorized it as a federal project.

CONTRACTS AND CAPITAL

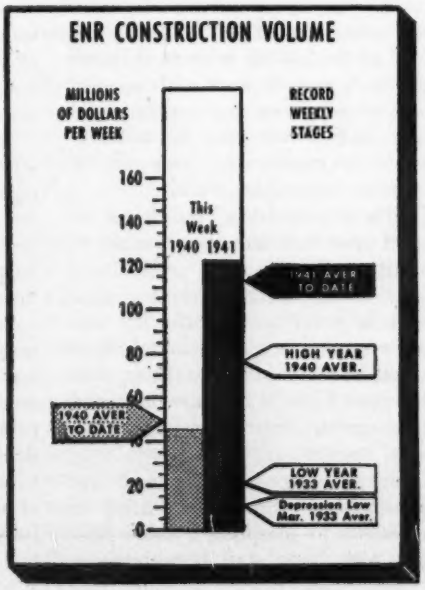
ENGINEERING CONSTRUCTION awards for the week, $126,284,000, top the volume for the corresponding 1940 week by 181 percent, and are 41 percent higher than a week ago. Private awards, the highest reported since October 31, 1940, are up 248 percent compared with the 1940 week.

The current week's awards bring 1941 construction to $1,461,248,000, an increase of 128 percent over the 13-week period last year. Private awards for the period are up 95 percent, and public construction is 144 percent higher than last year's 13-week total as a result of the 838 percent gain in federal work.

Industrial building volume reached the highest peak reported since October due to the $30,000,000 airplane engine plant at Melrose Park, Ill. In addition to industrial buildings, waterworks and public buildings gain over a week ago; and sewerage, commercial and public buildings, and unclassified construction top the 1940-week volumes.

New capital for construction totals $606,685,000 for the week. This compares with $11,698,000 for the week last year. The week's financing is made up of $376,000,000 in federal appropriations for additional plant facilities under the Aid-to-Britain Bill, $187,500,000 in federal appropriations for WPA construction, $43,145,000 in state and municipal bond sales, and $40,000 in corporate security issues.

New construction financing for the year to date, $1,332,653,000, tops the 13-week period last year by 459 percent.



CONTRACTS

(Thousands of dollars)

	Week Ending Mar. 28 1940	Mar. 20 1941	Mar. 27 1941
Federal	$5,102	$49,301	$56,221
State & Municipal	25,911	23,639	21,370
Total public	$31,013	$72,940	$77,591
Total private	14,005	16,618	48,693
TOTALS	$45,018	$89,558	$126,284
Cumulative 1941 (13 weeks)			$1,461,248†
1940 (13 weeks)			$642,741

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.
† Revised.

NEW PRODUCTIVE CAPITAL

	Cumulative 1940 13 weeks	1941 13 weeks
NON-FEDERAL	$238,343	$260,153
Corp. Securities	37,813	63,503
State & Mun.	109,292	157,149
U.S.H.A. loans	90,547	13,521
R.F.C. loans	691	25,980
FEDERAL		$1,072,500
TOTAL CAPITAL	$238,343	$1,332,653

FHA MORTGAGES

	Week Ending Mar. 23 1940	Mar. 15 1941	Mar. 22 1941
Selected for appraisal	$26,751	$30,561	$30,898*
Cumulative 1941 (12 weeks)			$286,739*
1940 (12 weeks)			$239,923

* Subject to revision.

ENR INDEX NUMBERS

Index Base=100		1913	1926
Construction Cost	Mar. '41	250.71	120.52
Building Cost	Mar. '41	207.88	112.37
Volume	Feb. '41	374	164

Comment and Discussion

Readers' opinions on matters that concern engineers and contractors

No Structural Steel Shortage

Sir: In your issue of March 20, on p. 4, you published the statement that priorities have been issued to manufacturers of large cranes. And you make the definite statement that this is the "first formal priorities on structural steel". That statement is incorrect. No priorities on structural steel, or cranes, were issued. The Priorities Board granted nine builders of electric traveling cranes a blanket preference rating of A-1-c. That was not a priority order whatever, but was the first time a blanket preference rating was given to a group of manufacturers, and, in this case, to only a few of the manufacturers in this business, i.e., the manufacturers of heavy cranes. And it was a new type of preference rating in that the holder of it may extend the rating to subcontractors on items listed by means of photostatic copies, these items being motors, switches and controllers, as well as steel bars, plates, shapes, forgings and castings. The amount of structural steel required in all of these can be taken from any one of a hundred or more stockpiles of structural shapes already in existence without seriously depleting any one of them.

It seems to us you do the structural steel industry a serious injustice by jumping at a conclusion, as you did in the article you published. I am in receipt of a letter, under date of March 17, from the Priorities Division, Office of Production Management, stating "no change has been made in the method of handling orders for structural steel shapes". That means that there is no shortage of structural steel shapes for defense work or civilian needs.

In your article you state: "To date, steel suppliers have been expected to give preference to defense orders in an informal way, but there have been no actual priority ratings applied." And you should have added that the preference rating issued to these nine crane builders does not change the situation in the least.

There is no shortage of shop capacity to fabricate structural shapes for defense or private needs. As a matter of fact, the structural steel needed for defense jobs has been shipped by the mills, fabricated by the shops, and shipped to the site sometimes several weeks in advance of the time the defense jobs were ready to start erection, and always as rapidly as the jobs were ready to receive the steel.

V. G. IDEN

American Institute of Steel Construction, New York, N. Y.

Improve the Status Of Engineers Now

Sir: The best time for engineers to improve their professional status is a period when unemployment in their field is slight, when their services are urgently needed, and when their individual incomes are relatively high. Such a time is the present.

It is noteworthy that, in a situation as now exists, both governmental bureaus and industrial organizations naturally turn to established engineering and architectural firms in private practice for rapid, efficient service instead of attempting to create or enlarge staffs of their own for urgent work of design and supervision.

It is not now considered unthinkable that important engineering work on very large projects should be entrusted entirely to private engineering firms, instead of following the trend of the last 20 years to do more and more of such work with salaried staffs of industries and governmental units, and of following the trend to use private engineering firms only for occasional consulting work.

Such a reversal of trend can be seized upon now as an opportunity to solidify gains in the professional status of engineers. Executive engineers in positions of authority with industries and in governmental offices can utilize more and more the services of private firms, if they are interested in enhancing the professional character of engineering work.

Younger engineers can seek out opportunities with private firms in preference to accepting humble positions with large staff organizations. The more difficult it is to obtain recruits for such staff groups, the more will be the volume of engineering work necessarily entrusted to private firms operating on a truly professional basis.

In all industrial and governmental engineering departments efforts should be made now by executives and subordinates to gain the amelioration of unprofessional conditions in the work of engineers. Low pay and servility should be banished. Young engineers should be definitely allowed time for professional study, trips for investigation and research, and attendance at meetings of engineering societies. Subordinate engineers should be encouraged to do original thinking and planning, and engineering work should be administered so that subordinate engineers can gain wide experience quickly. Such assistants should be allowed to inform themselves concerning all details of the project they are engaged upon, and should be treated as young practitioners, not as employees.

Private engineering firms who are now being entrusted with important work on a fee basis should resist the temptations to profiteer and to exploit young engineers, and rather should introduce operating methods calculated to improve the professional status of their key men and their subordinates. Profit sharing and professional working conditions should be the order of the day in such organizations.

There should be no room for private engineering firm practice such as that found recently in the Middle West, where a firm obtained copies of relief rolls in order to obtain names of engineers on relief who might be interested in obtaining engineering work at low pay.

As things have stood for the past 30 years, to consider civil engineering work as professional activity has been mostly wishful thinking. Low pay, bad working conditions and frequent unemployment have quieted the urge among many engineers to conduct themselves as professional men. Regimentation on the salaried staffs of industrial firms and governmental departments has usually robbed engineering work of that independence of thought and action which should characterize the work of truly professional men. No carefully drawn code of ethics can change that shameful fact.

Now we are engaged in a great effort to help preserve freedom of action for men who still consider themselves free men and to keep from our shores and the shores of other still free countries the pest of totalitarianism. Let us at this same time throw off the shackles of engineering regimentation and step forward as professional engineers who will not tolerate regimentation, servility and mediocrity.

ARTHUR WARDEL CONSOER
Consulting Civil Engineer
Chicago, Ill.

New Hiring Philosophy Needed

Sir: Unless employers change their specifications under which new men are hired, their only way to expand their forces will be to hire new men away from each other. This is the way things are developing, according to a recent statement by a prominent New England manufacturer.

Insistence on the rigid qualifications of yesteryear finds an almost complete lack of men having those qualifications. During the years of depression men were not being trained along those exacting lines. Apprentices were not coming along; neither were understudies in executive capacities.

New York City authorities recently have had to modify their requirements for vocational teachers. Those able to qualify under former specifications simply could not be found. By loosening up, the city feels that it will obtain thoroughly competent teachers, even though they cannot submit an experience record of quite the extent once asked.

What are the stipulations which industry will have to modify? There are several items.

First is the requirement that applicants must have had exact experience in a definite field, and that it must have been very recent. Experience in an allied line usually is not accepted, even though technical men always show great adaptability, as between one line and another. And the fact that a man has shown skill in a chosen line, but has been away from its exercise for a few years, does not mean that he cannot show that skill again, with a minimum of lost motion. But try to tell an employer that!

Next comes the requirement that a man must have had twenty years' experience "in our field," but must be not over thirty years old. Not so long ago New York City refused to permit a young woman to take examination under Civil Service for a clerkship. Why? Merely that she was twenty-nine; the age limit had been set arbitrarily at twenty-seven. That one went to the courts.

Some day, in some way, this log jam will have to be broken. How much punishment the country must take before this comes about no one knows. Possibly we shall "muddle through," as we have been able to do in the past. But why, in the name of common sense, should we have this handicap to hurdle?

Plenty of technical men are able to fill existing specifications perhaps 90 percent. Is it not far better to put these 90-percenters to work, with the certainty that a few weeks will see them become 100-percenters, than to muddle along with inadequate help, just to maintain outworn "standards"?

SIDNEY G. KOON
Flushing, New York

Suspension Bridge Failures

Sir: My attention has been called to the fact that the casual reader may infer, from my brief historical review of wind failures of suspension bridges (*ENR*, March 13, 1941, p. 402), that the modern bridge engineer, in view of the earlier failures of these bridges, was remiss in not anticipating a similar action in our light modern structures. No such inference was intended but the author regrets that he did not make a specific statement on this point.

I take it that no great exercise of the imagination is required to picture the light floors of the early structures tossed about by the action of wind. I am informed, for example, that the floor of the Wheeling bridge, which failed in 1854, weighed but 23 lb. per sq.ft. and it was thus possible for this floor actually to be lifted by direct wind action. On the other hand, the so-called "light" floor systems of our modern bridges must not be compared with these old timber platforms. For example, the center span of the Wheeling bridge totaled 460 tons as compared with 8,000 for Tacoma, 13,000 for Bronx-Whitestone and 56,000 for George Washington. It is thus unreasonable to assume that the modern engineer, knowing of the earlier failures, should have anticipated the possibility of a similar action in these relatively much heavier modern structures. As most people observe upon seeing the films of the Tacoma failure: It's unbelievable.

Furthermore, no engineer, as far as I know, recognized in the twistings of some of these earlier failures, a characteristic aerodynamic phenomenon and certainly could not have been expected to grasp the combined mechanics of the cables, storing up, like two great pendulums, the small increments of energy imparted to them by undulations induced by wind action on the floor. Let us recall that even our best modern mechanicians were, at first, stumped to explain what happened at Tacoma. In short, it is asking too much of the human mind to suggest that the engineer should have anticipated the Tacoma failure.

It is also a mistake to assume that failures should never occur. The engineer cannot wait until he knows "all" about a device before he builds it. In general, theory follows practice—the theory of heat followed the first use of the steam engine, truss analysis came after the truss, etc.—and there has, as yet, been no substitute developed for experiment—even in science. A history of bridge building which contained no records of failures would be a history almost devoid of progress. Man must ever struggle to bring into being the children of his imagination, for through such creation progress is possible. It is thus inevitable that, in daring to do bigger and better things, there will always be some failures. Failures, in fact, are a sure indication of progress. While a failure is always materially wasteful, it is always a stimulant to increased knowledge. We may rest assured that the engineer will not make the same mistake twice.

The earlier failures of suspension bridges offer, *in the light of modern knowledge*, some teachings which the author attempted to summarize in the last part of his paper, but he did not suggest, or intend the reader to imply, that the modern engineer should have known the details of these earlier disasters and should have anticipated the Tacoma failure. That the Tacoma design was unique and daring was well recognized. That it would fail *as it did* was an event which human foresight could not anticipate.

J. K. FINCH
Renwick Professor of Civil Engineering
Columbia University, New York

EDITORIALS

VOLUME 126 NUMBER 13

March 27, 1941

A Ghost Stirred Up

WHAT MEMORIES of heated controversies are raised by the proposal of Representative Mansfield, chairman of the rivers and harbors committee of the House, that the Panama Canal be deepened to a sea-level canal as a defense measure! Thirty-five years ago the sea-level versus lock canal controversy was at its height. As John Stevens succinctly put it in his "Recollections" (*ENR*, Aug. 15, 1935, p. 216), "Most non-engineers were attracted by the alluring phrase 'sea level'." But not a few engineers, also, favored the sea-level route. In the end the argument that a lock canal could be built more quickly, at much less cost and with greater assurance of success prevailed. Control of the torrential Chagres River was a major factor in reaching that decision, a fact which the present-day advocates of a sea-level canal doubtless have overlooked. They may also have forgotten the great slides in Culebra Cut that blocked the canal for months at a time. Such slides in a newly dug sea-level canal offer greater menace to navigation than bombing does to the lock canal. The third set of locks now under construction, guarded by new and ever growing air-defense facilities, will give much greater assurance of a safe passage for the fleet. The sea-level canal is a ghost that should be left to sleep in peace.

Planning Plus

THOSE WHO LAMENT that there is "too much planning and not enough action" should be pleased by the latest report of the National Resources Planning Board, which was transmitted approvingly to Congress by President Roosevelt. Among other things, this report recommends that a revolving fund be established to finance the preparation of designs and specifications of post-war public works projects. In other words, this type of planning goes beyond the water-color sketch stage and gets down to fundamentals outlined in India ink. Since chances are that in the post-war period large sums will be made available for public works, having the plans ready will assure a quick start. Working on this theory the NRPB wants $85,000,000 now to put projects into shape. The design costs would be subtracted from the construction appropriation when a project got under way and put back into a revolving fund for more design work. This idea has lots of merit—it gives a plus value to planning which brings plans closer to action.

Credit Where Credit Is Due

WHEN THE ARMY CAMP construction program first got under way, the question of sewage disposal facilities came up. Someone reached into the files and dusted off plans of the Doten tank, a type of septic tank widely used at cantonments in 1917. The Doten tank was a useful device in its day but sanitary engineering has taken vast strides forward. Happily, the brief perusal of Doten tank installations proved to be nothing more than an impulsive gesture. And in this issue, we can point with a great deal of satisfaction to the up-to-the-minute design recommendations for Army sewage treatment works. Prepared by recognized civilian experts in sanitary engineering, the recommendations represent the latest thinking in sewage works design based on experience and practical test. Here, then, is another of numerous examples of sound engineering procedure applied to present emergency work. Mistakes are being made, it is true, but let us be quick to acknowledge credit where credit is due.

Designed for Public Service

A CITY HALL has come to be accepted by the average citizen as a public building erected by the municipal administration as a monument to its regime, all too frequently accompanied by rumors of "diversions" of public funds. By contrast the Queens Borough Hall, recently completed by the City of New York, presents a pleasing relief, and may well symbolize the city hall of the modern community, designed for public service and efficiently and honestly built. The planning of Queens Borough Hall, as reviewed in this issue, was based on functional needs, including the convenience of the citizens using their building, and the proper size and arrangement of space for the municipal staff. The housing for these services was designed with a minimum of embellishment, and in a style suggestive of efficiency and service. During the three months allowed for design and the nine months required for construction, which represents half the usual period for a structure of this size and type, the cooperation of engineers, architects and contractors resulted in saving days and dollars at a rate almost unknown on public building

projects. The result is a modern city hall symbolizing service to the public in a strictly functional building. As to cost, the figure of $6.65 per sq. ft. for the present project, as compared to $81.82 for the old Tweed Court House, speaks for itself.

Better, If Conditions Permit

ADOPTION of competitive lump-sum contracts for practically all future work in place of negotiated fixed-fee agreements, as planned by the construction division of the Quartermaster Corps, is a wise move if it can be carried out. Lack of time to prepare bidding plans justified the negotiated contract for the rush jobs of last fall, but if there is now opportunity for preliminary designing, and if the contractor is given an escape from rising materials and labor prices, the jobs can probably be done better under the more familiar lump-sum competition. As a matter of fact, some lump-sum jobs have already given a good account of themselves, the $9,000,000 Fort Ord cantonment described in this issue being one. On lump-sum work the contractor is relatively free to make his own decisions; he knows he is accountable for results, and that his efficiency will make him a profit. Future Army contract work will benefit from lump-sum contracts if conditions will permit their use.

New Chance for Better Concrete

ONE THING CAN BE SAID of concrete that is hardly true of any other material: After a half-century of development, during which it has contributed mightily to advancement of the engineering art, it is still new and challenging. Time and again it has seemed that some researcher had hit upon the secret of making top-notch concrete consistently, only to have his theories partially upset or completely disproved by a structure going bad or a new theory gaining credence. Fortunately these discouragements have in no wise throttled either curiosity or enthusiasm because concrete is too necessary a material to allow any flagging of interest in its development.

It is against such a background that a new theory on the cause of surface cracking is now advanced, involving a damaging reaction between the cement alkalis and the aggregates. Based on discoveries of Thomas E. Stanton that crazing and cracking of concrete pavements in California are a result of using certain aggregates with high alkali cements, as reported in our Feb. 1, 1940, issue, and on the belief of the Bureau of Reclamation that the same cause is behind serious surface cracking on Parker Dam, as reported by R. F. Blanks in this issue, the theory is off to a good start. Should it be substantiated by investigation and experience, one of the most troublesome sources of lack of durability in concrete would be eliminated. And the profession, incidentally, would owe the Bureau of Reclamation a great debt of gratitude for deciding to make the Parker Dam problem public—a difficult decision at best, but one that expresses the highest type of professional action.

There are, however, two schools of thought that will receive something of a jolt if the theory has a sound basis. First, those drafters of cement specifications who have regarded the alkalis (principally oxides of sodium and potassium) as of so little consequence that the percentages present are not even listed among the chemical constituents of cement will have to make some changes. And the second group that will have to mend its ways includes those who still think all aggregates are inert filler material. Even if, upon examination, the role of the alkali-aggregate reaction in causing surface cracking proves to be less than spectacular, the conclusive evidence of its existence will be a boon to concrete development, since it will emphasize that the whole mix may be chemically active. After a long period of concern with cement and its compound composition, with water-cement relationships and with aggregate toughness and durability, each as a separate problem, it would be refreshing and perhaps productive to study concrete as concrete.

Should the alkali-aggregate theory prove true, either one of two courses would seem to be open: to seek out those aggregates that react deleteriously and prohibit their use, or to limit the alkali content of cement. Neither alternative, however, should be adopted lightly for they both will entail hardships either for the user or the cement manufacturer. Rather as Mr. Blanks suggests, it is up to everyone "who has the temerity to consider himself a student of concrete" to weigh this new diagnosis of crack causation by every means at his disposal. Another step toward better concrete durability may be in the making.

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Alkali-aggregate reactions have produced extensive random-pattern cracking on the exposed concrete at Parker Dam within two years after this structure on the Colorado River was placed in service.

Concrete Deterioration at Parker Dam

R. F. Blanks

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Bureau of Reclamation, Denver, Colo.

***Contents in Brief**—Random-pattern cracking on the exposed surface of Parker Dam concrete is attributed to adverse chemical reaction between the alkalis of the cement and siliceous minerals in the aggregate. Alkali content (Na_2O and K_2O) of cement used in exposed section of dam was 1.42 percent. Cracks extend to a depth of only 6 to 8 in., which corresponds to the extent of complete surface drying in the concrete. Pending further research on alkali aggregate reactions, the Bureau of Reclamation has imposed a 0.60-percent limit of alkali content for cement used on its important works.*

LESS THAN TWO YEARS after completion, serious deterioration began to develop in the concrete of Parker Dam, located on the Colorado River about 175 miles below Boulder Dam. This condition was evidenced by a widespread development of random-pattern cracking on the exposed surfaces which, upon investigation, was found to be accompanied by internal expansion and disintegration of the concrete due to adverse chemical reactions. While this is the only case of comparable disintegration among the 54 concrete dams (representing about 30,000,000 cu.yd.) constructed by the Bureau of Reclamation, similar conditions in varying degree have been observed in concrete structures located throughout the United States.

In this modern age of "advanced" concrete knowledge, there can be only one extenuating condition attending the early development of serious deterioration in a $6,000,000 structure such as Parker Dam. This condition is that the knowledge of concrete be advanced and ultimately lead to benefits far exceeding the cost of any remedial measures that may eventually be required. Far-reaching investigations are now under way or are being initiated by the Bureau of Reclamation in cooperation with various cement manufacturers and other interested organizations to supply much needed information and to develop answers to the many questions concerning the behavior of concrete which at present appear so obscure.

High-alkali cement used

Parker Dam is a constant-radius arch structure 320 ft. high, 95 ft. thick at the lowest elevation, and 800 ft. long at the crest. Less than 100 ft. of the top portion of the dam, which includes the abutment blocks, spillway gates and piers, roadway, gate towers and operating house, extends above the tailwater elevation. The first concrete was placed in the

dam proper in July, 1937, and the 276,204 cu.yd. of concrete work was practically completed by July of the following year.

The concrete work was accomplished in accordance with recognized best practice in the selection and utilization of materials for mass concrete construction, with equipment and personnel which afforded excellent technical and operating control. The aggregates were selected only after exhaustive search and investigation had been conducted to locate the most suitable source.

The deposit selected was located on the Bill Williams River about ½ mile above its confluence with the Colorado River, immediately above the Parker Dam site. Samples of the natural aggregates from extensive test pit excavations were subjected to all the usual, and some unusual, physical and concrete performance tests. The results from all these investigations indicated conclusively that the aggregates used in the concrete for Parker Dam were well above the average as to physical and concrete-making properties.

Four brands of low-heat-type portland cement were used, having alkali contents (Na_2O and K_2O) of 0.55, 1.13, 1.25, and 1.42 percent, respectively. The sodium oxides predominated. In that portion of the dam exposed to view, only one brand of cement was used—that containing the highest percentage of alkalis.

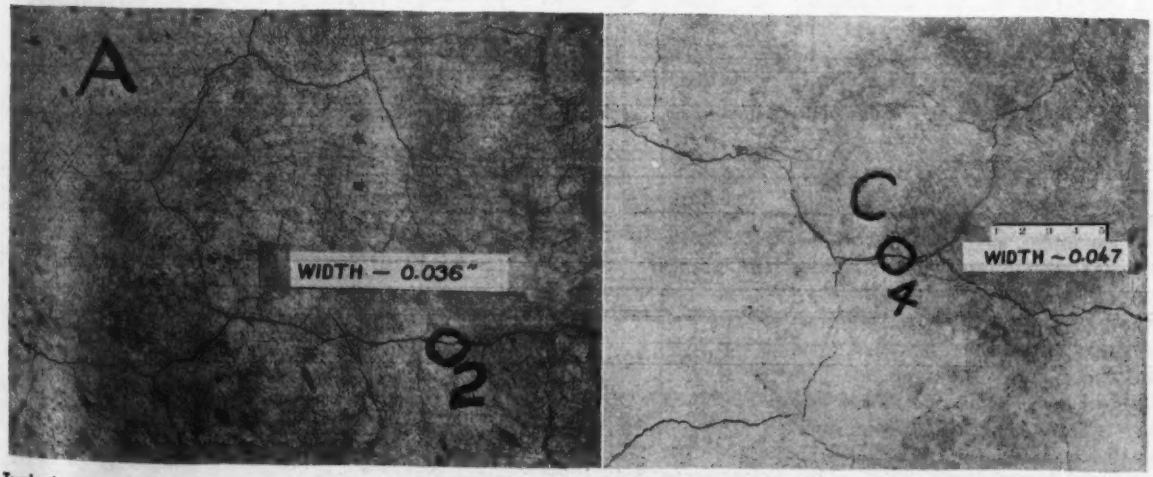
Development of cracks

Cracking of the concrete in Parker Dam became noticeable in the spring of 1940 and progressed rapidly with the advance of hot summer weather, until the exposed surfaces were literally covered with a network of random-pattern cracks. Information regarding this cracking has been developed with the aid of drill cores. It has been found that the cracking is, so far, more or less superficial. Although some of the cracks have opened more than ¼ in. at the surface, they extend into the concrete only 6 to 8 in. Computations indicate that this depth is about the extent of complete surface drying of the concrete to date.

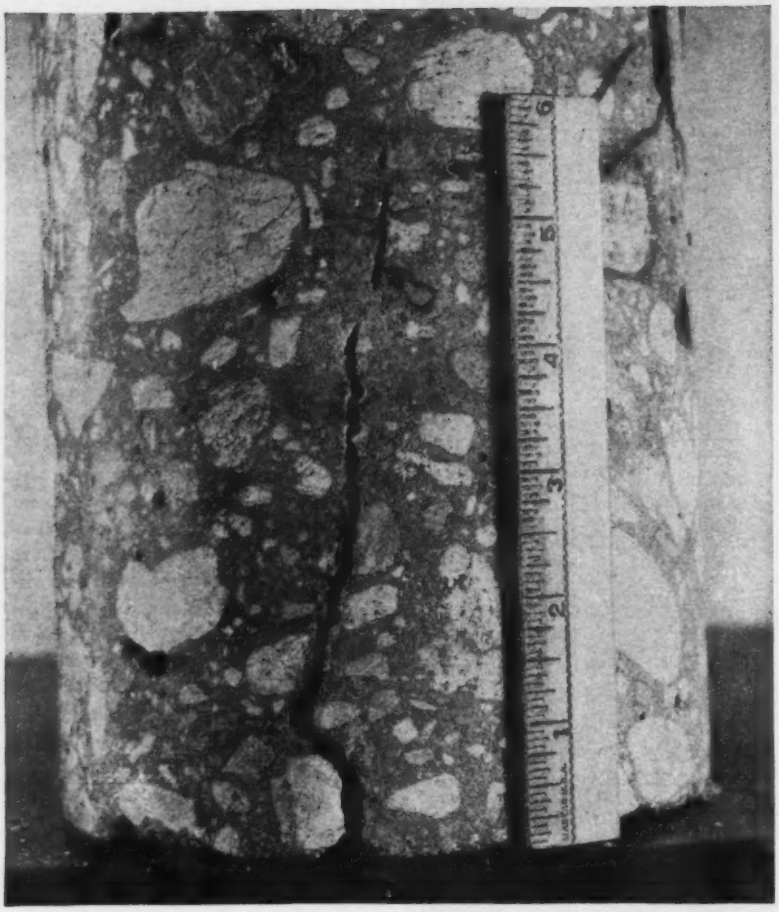
Sodium-silicate-gel, which hardens on drying, exudes from cores drilled and stored in the presence of moisture.

Study by instruments

Holes have been drilled into the concrete to varying depths up to 87 ft. in which instruments have been installed to measure movement within the mass. The interior concrete, where residual mixing water is still available, is expanding due to chemical activity, while the dry outer shell is shrinking with progressive drying. An aggravated crack-development condition is thus set up. The surface cracking diminishes from the top of the dam downward and entirely disappears at water surface. The diagram shown in the accompanying illustration records data that are now available from the drill-hole extensometer readings. It will be noted that the temperature was gradually dropping during the period represented. The first 2½ ft. reflects the dropping temperature and continued drying by a net contraction, while at 2½ to 5-ft. depths some expansion is recorded, and at depths of from 5 to 10 ft. very high expansion is indicated.



Typical appearance of surface cracking on Parker Dam which is accompanied by internal cracking and disintegration caused by adverse chemical reactions. Cores indicate the formation of a sodium-silicate-gel in the pores of the concrete.



Cracks, which have an opening of as much as ⅛ in. at the surface, extend into the mass for a distance of only 6 to 8 in., as indicated by this drill core.

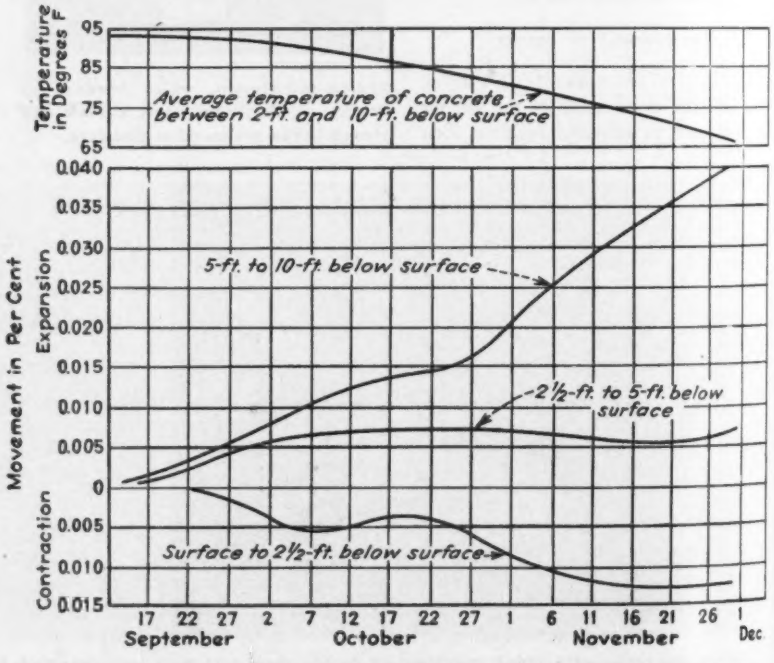
When the concrete cores are extracted and stored in the presence of water, a gel-like substance exudes from their surfaces. This gel is also found throughout the concrete in the small cavities and voids. Upon drying, the gel hardens to a whitish-gray deposit with enormous shrinkage. The gel has been positively identified as sodium silicate (water glass).

The cores taken from Parker Dam further reveal that certain aggregate particles in the concrete are not content with the role of an inert filler material and evidence such discontent by undergoing chemical alteration. Apparently the sodium-silicate gel is a product of reaction between the alkalis in the cement and siliceous minerals contained in certain altered andesite and rhyolite aggregate particles. These rocks constitute less than 2 percent of the aggregate used in the production of Parker Dam concrete.

There is a growing chain of evidence confirming the suspicion that the occurrence of aggregates carrying minerals susceptible to attack by alkalis in cement may be widespread. In addition to Parker Dam and the California highway structures reported by Thomas E. Stanton, materials and research engineer, California Division of Highways who first discovered that delayed expansion of concrete may be caused by alkali-aggregate reactions (*Engineering News-Record*, Feb. 1, 1940, and *Proceedings*, American Society of Civil Engineers, December, 1940), the list of similar cases now under observation in various parts of the country, from the Atlantic to the Pacific coasts and from the Canadian to the Mexican borders, is steadily growing. The aggregate materials which may be reactive in the presence of alkalis in cements now number not less than eight and include many common igneous, sedimentary, and metamorphic rock types.

Other deleterious effects

In addition to the observed reactions taking place between alkalis in the cement and the andesitic aggregate particles, it is apparent from microscopic examination of the Parker Dam concrete that disruptive forces are working on the cementing matrix. The condition of the hardened paste cannot be adequately illustrated in a photograph but to the eye



Internal expansion and surface shrinkage of the concrete shown by records from instruments installed in drill holes.

it appears dead, sugary, or powdery. The late Thaddeus Merriman would no doubt have said that it lacks "amorphous constituent." Regardless of what descriptive terms may be used, little is yet known concerning the actual processes involved in this dissociation of the cementing medium. It may have its origin in the paste itself or it may be directly or indirectly connected with the alkali-aggregate reactions.

The results of compressive strength and modulus of elasticity tests of the Parker Dam concrete as shown by the accompanying tabulation are considered significant. While the cores drilled in 1940 tested considerably lower in strength than the other test specimens, the most significant fact is the comparatively low modulus of elasticity of the late cores as shown in the tabulation below. Elasticity is considered one of the best indices of deterioration in presently used durability tests.

Test	Compressive strength	Modulus of elasticity
90-day laboratory test, 18"x36" cylinders	3,980	4,800,000
1-year laboratory test, 6"x12" cylinders	4,620	4,200,000
28-day field control tests, 6"x12" cylinders	4,120	—
6"x12" cores, drilled 1938	4,180	3,800,000
6"x12" cores, drilled 1940	3,480	2,200,000

Some evidence has been collected which indicates that alkalis in cement may be associated with certain cases of surface crazing, checking, and small-pattern cracking of the type so commonly observed in concrete which leads to unsightly, and sometimes, serious deterioration. This condition apparently has no connection with aggregate reactions but may involve aggravated volume changes upon wetting and drying, due to concentrations of alkali compounds at or near exposed concrete surfaces. The association of alkalis in cement with excessive surface checking seems to be borne out by our own observations as well as by those of Bailey Tremper, testing engineer, Washington State Highway Department, and H. S. Mattimore, Pennsylvania State Highway Department.

Basic research needed

While the alkali situation in the light of present knowledge is admittedly uncertain, it is believed that concrete should not be condemned as a suitable material for building great projects which must last for centuries instead of merely decades. The Parker Dam case is not new; on the contrary, it is apparently an old and rather common ailment with a new diagnosis. The investigations now under way are designed to solve the immediate problems involved and prevent a recurrence of the Parker Dam situation.

Methods must be developed for predetermining the combinations of materials which might be expected to give trouble when they are combined in concrete. Since satisfactory methods for determining such combinations have not yet been evolved, the Bureau of Reclamation has, for the time being, resorted to the only apparent alternative—the imposition of a limitation on the alkali content of portland cements. For its large and important works, the limit has been set at 0.60 percent.

Is this expedient adequate? Is such a limit too restrictive or too costly? Should some aggregates be condemned for use in concrete, and other materials and other types of construction be used? Are there other more satisfactory corrective measures, such as effective neutralizing agents? These are some of the questions which are being intensively investigated at the present time.

However, it is not sufficient merely to solve the immediate problems connected with the effect on concrete of alkalis in the cement. In the development of concrete knowledge, attention has been concentrated on adapting this versatile material to the ever-increasing demands of modern engineering for greater production speed in order to bring presently-conceived great projects into the realm of economic feasibility. Engineers and investigators have sought—and found—ways and means of overcoming the inherent limitations of concrete as a building medium in order to meet these demands. In so doing they have failed to keep pace with basic research to develop the fundamental reasons why the inherent limitations exist.

It is quite possible that the presence of alkalis in cement may have far-reaching implications and that many instances of concrete distress, only vaguely explained in the past, may ultimately be clarified when all factors involved become known. The hieroglyphic crack symbols that have been written on the exposed surfaces of Parker Dam and on other structures are a challenge to concrete investigators to solve the basic problems involved and "close the gap between research and practice."

To accomplish this will require the concerted efforts of the cement and aggregate industries, every organization which maintains concrete laboratory facilities, and every individual who has the temerity to consider himself a student of concrete. Until it is accomplished, we can only hope to make concrete deserving of the designation "permanent."

Municipal Moving at Shawneetown, Ill.

IN TRANSFERRING the town of Shawneetown, Ill., to a new and high-level location, to avoid the frequent flooding on the original site, it was desirable to salvage water supply facilities as well as move dwellings to a new location, a distance of three miles. In September, the State Division of Waterways let a contract for the removal of 26 dwellings over streets and public roads to new foundations built by the Gallatin County Housing Authority. These foundations are built only to the ground level, to facilitate placing the buildings in position on blocking or cribbing at the required elevation, the walls being then built up to support the structure. Certain buildings of historical interest will remain at their original locations, as part of a state memorial park. This removal work is under the direction of Carter Jenkins, chief engineer of the State Division of Waterways. A new water supply has been developed from a drilled well, and the old cast-iron mains were pulled up and relaid at the new location. As this water has a high iron content, it is proposed to move the old iron-removal plant to the new town. The new sewerage system and disposal plant, designed for a population of 2,500, consists of a screen chamber, Imhoff tank, trickling filter, secondary settling tank, drying beds for handling the sludge, and pump house.

Cleveland traffic to and from the Main Ave. Bridge passes over country's longest span girders.

Girder Span Record Boosted to 271 Ft.

Fred L. Plummer
Formerly Design Engineer, Cuyahoga County
Warren, Pennsylvania

***Contents in Brief**—Cleveland viaduct approach to Main Ave. Bridge contains a 271-ft. plate girder span, longest in the U. S. Crosses railroad tracks at a severe skew. Erection pieces up to 140 ft. long handled by locomotive crane and deck traveler. Piers are steel shells filled with concrete resting on a 7-ft. concrete mat placed inside a steel sheetpile enclosure.*

THE LONGEST SPAN steel girders constructed in the Americas to date, 271 ft., are used in the Lakefront Ramp of Cleveland's Main Avenue Bridge. This ramp, which connects the east approach of the bridge with Lakefront Road, has a total length of 2,530 ft. and provides two 24-ft. roadways with a raised dividing curb at the center and narrow escape walks at the sides in its 55-ft. width. In addition to the long girder spans, which are part of a 4-span continuous unit, the ramp contains 1,200 ft. of rigid frame construction in a series of eight 2- and 3-span sections made to function as continuous span units by connecting links capable of transmitting either positive or negative shear forces. Because of the horizontal curvature of this part of the ramp and of many skew underpasses the two lines of frames, spaced 35 ft. apart, are largely dissimilar, and spans vary from 13 to 122 ft.

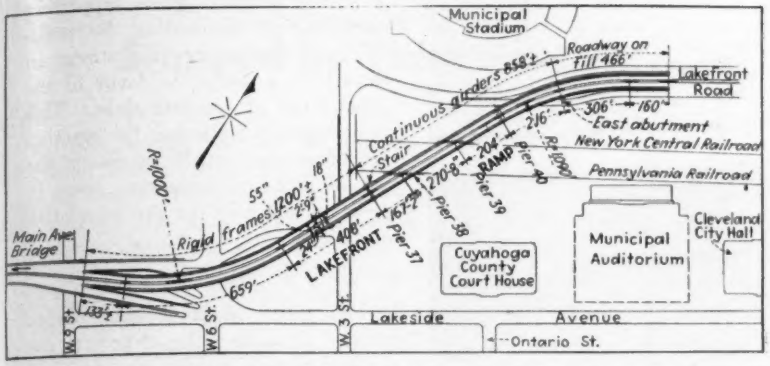
At the opposite end of the Lakefront Ramp from the rigid frames the construction consists of fill placed between reinforced concrete retaining walls, but it is the intermediate section, a 4-span continuous girder layout three girders wide that is most interesting from a design and erection standpoint.

Layout of the girders

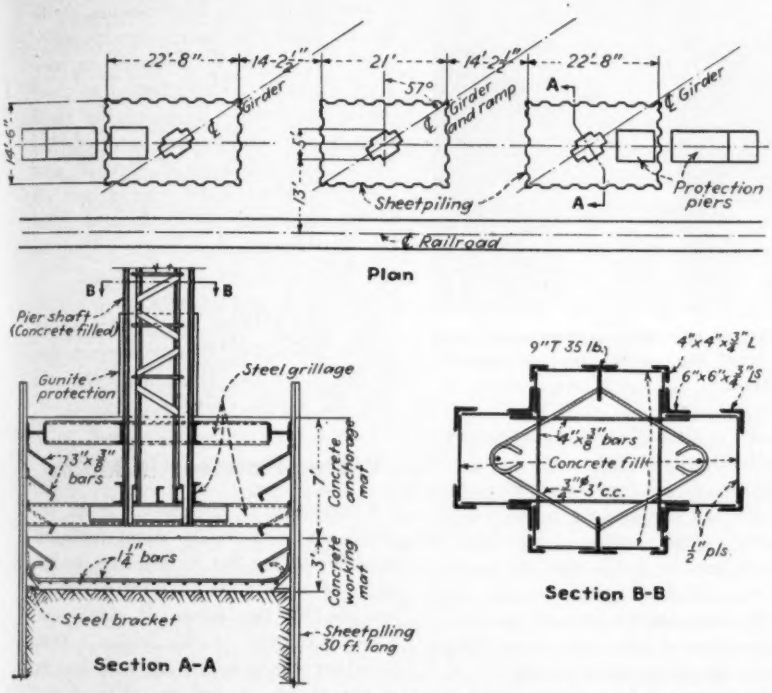
The girder construction crosses the tracks of the Pennsylvania and New York Central railroads at a skew of 57 deg. and with a span of 270.8 ft. Other spans are shown on the drawing. The girders, spaced 19 ft. 6 in. on centers, are 12 ft. deep throughout the central portion of each span, increasing from this depth at points 60 ft. distant from each intermediate pier, to a depth of 15 ft. 8 in. over these piers. The thickness of the girder webs varies from $\frac{5}{8}$ to $\frac{3}{4}$ in. The minimum flange section consists of two 8x8x$\frac{3}{4}$-in. angles and one 22x$\frac{3}{4}$-in. plate. For the maximum flange section the cover plating is increased to $3\frac{1}{2}$ in.

Because the roadway follows a horizontal curve of 1,090-ft. radius for a distance of about 282 ft. at the east end of these girders, it was necessary to design for a horizontal bend in the girders at Pier 40. In order to simplify expansion details, this pier was selected as the "anchor" pier, and the girders were supported on rockers at the remaining piers. At Pier 40 the adjacent girder lower flange and web sections are milled to bear and connected to a vertical wedge-shaped plate which transmits the load to the bearing casting. Heavy transverse bracing is designed to resist the forces resulting from the change in direction of the girders.

The bridge deck (a steel grid filled with concrete) is welded to joists resting directly upon the three lines of girders and forming the only upper lateral system, except at sections ad-



Lakefront ramp to Main Ave. Bridge at Cleveland permits traffic to bypass business district south of Lakeside Ave.



Plan and details of combination steel and concrete piers anchored to heavy concrete mat placed inside a steel sheetpile inclosure.

jacent to the skew piers (38 and 39) and at Pier 40 where the change in longitudinal alignment of the girders occurs. Lower lateral bracing, consisting in general of double angle sections, is provided in the planes of the girder flanges except at sections near the piers where it is kept above this plane in order to simplify connections. Crossframes of the Vierendeel type are provided at about 18-ft. intervals. Heavy truss crossframes are provided at the skew piers and at the anchor pier.

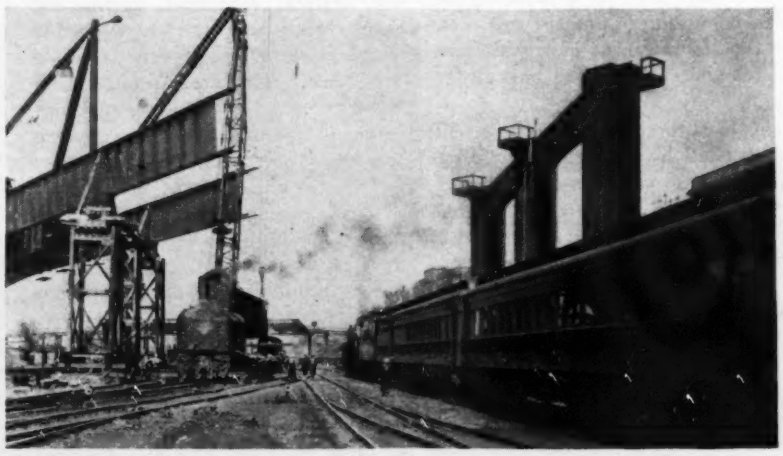
Design of girders

The structure is designed for H-20 loading, the floor joists for continuity over the three girders and the girders as fully continuous throughout the four spans. A preliminary analysis of the girders was made using approximate coefficients selected from tables appearing in a publication of the writer (*Statically Indeterminate Structures*—Edwards Bros., Ann Arbor, Mich.) and following the method of moment distribution. Based on these results, and using distributed loads, a preliminary design of the girder sections was prepared and the corresponding variation in moment of inertia determined.

The coefficients were then computed analytically and used in a slope deflection analysis as outlined in the publication previously referred to. These results were used to plot a curve of maximum moments. The thickness and length of cover plates were then determined more accurately. In the case of the south girder a new set of coefficients was computed and used for a check analysis. However, the variation in the final curve of maximum moments was not sufficient to warrant further changes in the design. This check analysis was not considered necessary for the other two girders. The method of "fixed points" was also used for studying certain load effects.

The specifications required that the contractor check the analysis and design of these girders, which he did, and, in addition, retained Professor Eney of Lehigh University, who made a model analysis of all three of the girders.

It was necessary to design the Vierendeel crossframes, especially those at the skew piers, so that they would have sufficient strength to resist all active forces and yet with sufficient



Girders were erected by locomotive crane and deck traveler working together.

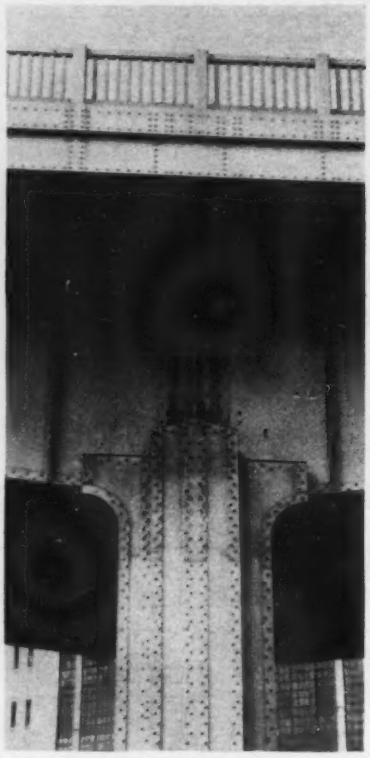
flexibility to allow the necessary differential vertical movements between the girders to take place without overstressing the frame material. In order to do this and also in order that proper camber might be provided, complete deflection studies were conducted for all critical load conditions.

Piers and foundations

Space limitations and unfavorable soil conditions made the design of adequate foundations an extremely difficult problem. Because the railroads have an option on the property north of their present tracks and have planned the addition of a number of tracks there, they refused to allow a width of more than 5 ft. above track grade for Pier 39. Borings at the site of this pier indicated a few feet of cinder and dirt fill, and then from a few to as many as 19 ft. of what was evidently an old stone breakwater. Under these stones there is a layer of soft to medium clay over 100 ft. thick.

The 5-ft. width allowed by the railroads was to be normal to their tracks and thus at an angle with the direction of the girders. This further limited the shape and size of the pier shafts which had to extend from a level 4 ft. below top of rail to the bottom of the girders some 40 ft. above. In consequence steel shell piers filled with concrete and shaped into the form of a cross were used. The combination steel and concrete shafts were anchored into a 7-ft. concrete mat with a steel grillage which also ties the pier to the steel sheetpiling that surrounds this mat. The 7-ft. anchorage mat is carried on a 3-ft. working mat poured on the underlying clay soil and also tied to the sheetpiling, which is driven some 20 ft. below the bottom of this mat. The tops of the three pier shafts are tied together with a steel box girder strut.

The construction for piers 38, 39 and 40 is of the same character. Pier 37, which also supports stone pylons at the west end of the girder spans, and is founded on filled ground to a depth of 25 ft. or more, is supported by similar mats tied to steel sheetpiling driven through the fill material. The east abutment is supported on spread footings placed on older and better consolidated fill materials. The foundations for the rigid frames consist in general of spread footings placed on sand soils which were found to have good load bearing characteristics.



Detail of pier showing treatment used to mask the rocker support for the girder.

The large girders were shipped to the site in sections up to 140 ft. in length overall. These were placed in position by a traveler starting at the east abutment and moving west on the completed structure, aided by locomotive cranes operating from tracks on the ground below.

Due to a number of factors it was essential that the girders be maintained in a predetermined horizontal and vertical alignment during the time when lateral and cross bracing members, including the floor joists, were being riveted. Among these factors were: (1) the horizontal curvature in alignment and the resulting super-elevation in the deck structure; (2) the vertical curves necessitated by changes in grades; (3) the longitudinal continuity of the girders throughout their entire length; (4) the continuity of joists, crossframes and brackets in the transverse direction; (5) the large skew of piers 38 and 39 creating the necessity of providing for comparatively large relative vertical movements of the girders at these sections; and (6) the fact that the concrete-filled steel deck grid is welded directly to the supporting steel thereby eliminating the possibility of making any adjustment in elevations, a factor in favor of the older types of concrete slabs. This very much complicated the erection procedure and made necessary the use of jacks on temporary bents in order to maintain the proper relative elevations.

Direction

The entire Main Avenue Bridge project, including the structures described in this article, was designed and constructed under the supervision of the office of Cuyahoga County Engineer John O. McWilliams, with W. E. Blaser as county bridge engineer and Ralph W. Deitrick as resident engineer. The writer was chief design engineer. Some of the rigid frames were fabricated and erected by the R. C. Mahon Co., Detroit, and the remainder of the frames and all of the girders by the Bethlehem Steel Co., Bethlehem, Pa., both acting as subcontractors of the National Engineering & Contracting Co., Cleveland. For articles on the remainder of the Main Ave. Bridge project, see *ENR*, April 11, 1940, p. 494, and July 18, 1940, p. 91.

Water-Hammer in Mains

Connecting a city water main directly to a railway water column used for filling the locomotive tender tanks is a practice that often causes trouble in the form of persistent water hammer in the mains. This problem was brought out in a report at the recent annual meeting of the American Railway Bridge and Building Association in a report on modern facilities for supplying water rapidly to large tenders and for high-speed trains. It was shown that water columns are equipped with slow-closing valves which gradually choke the supply and reduce the rate of flow in the pipe to such a point that the water hammer developed by the final closure of the valve can usually be handled by a relief valve. The problem is not likely to be serious when the water column is supplied by a railway storage tank, as the pressure head is then rarely more than 60 ft., or 26 lb. per sq.in. But when a water column that delivers 5,000 gpm is connected directly to a city main under 75 to 85-lb. pressure, water hammer is a real problem.

"Breathing" in Steel Siphons Stopped by Thicker Pipe Metal

WORK started last fall on replacement with heavier metal of thin steel portions of five siphons on the Los Angeles Aqueduct. This is the first of work done in replacing $\frac{1}{4}$ and $\frac{5}{16}$-in. metal with pipe made of $\frac{3}{8}$-in. plates. The work of replacement on three of the siphons which was completed last fall extended over 45 days during which time the flow of the aqueduct had to be shut off. The two remaining replacement jobs were timed to fit the permissible shut-down period during February and March of 1941. All of the replacement work must be divided up and scheduled in such a way that the aqueduct will not be shut down longer than the city's water service can be maintained by supplies stored in reservoirs near the lower end of the line. In spring and fall water deliveries can be suspended with least inconvenience and it is at these times that at least short shut-downs are always scheduled and careful inspections of the aqueduct interior are made, as described in the article on "Aqueduct Maintenance," *Engineering News-Record*, June 6, 1940.

Other than in repairing breaks, this replacement of thin metal is the first major reconstruction done on the 10 miles of steel siphons since the 233-mile aqueduct was put in service 27 years ago. This work, however, has been contemplated for several years past partly as the result of constant flexure in "breathing" and partly as the result of gradual corrosion. The $\frac{1}{4}$ and $\frac{5}{16}$-in. metal plates are not stiff enough to resist the recurrent stresses caused by the surge of water. This surging occurs only at the upper ends of the siphons, where the pipe is often only partially filled.

No effective remedy was ever found for this breathing and it was finally decided to replace thinner portions of the siphons with $\frac{3}{8}$-in. metal which has been found to retain its shape despite the surging that tends to cause breathing. This is expected to avoid the difficulties and maintenance costs incidental to the constant movement and also to check the tendency of the thinner metal pipes to flatten and buckle whenever the siphons are emptied. In addition to replacing these thin metal sections, a considerable amount of excavation and backfilling was required as well as some 6,000 cu.yd. of concrete in piers and anchors. Total contract price for the work done last fall was $496,253.

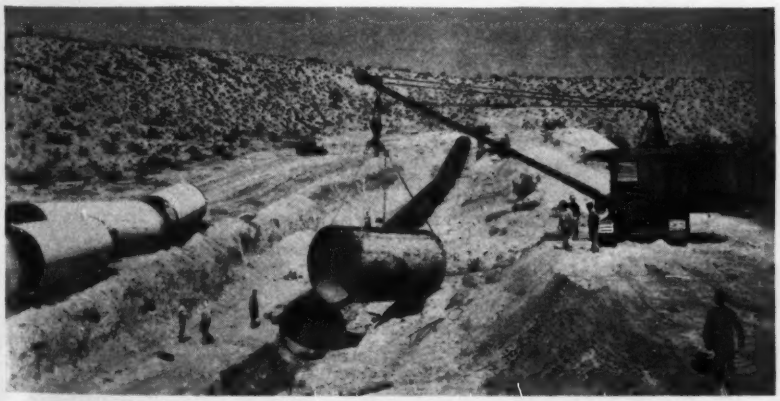
When the aqueduct was built, only riveted joints were made. The reconstructed parts of the line, on the contrary, use welds exclusively in field as well as in shop joints. In addition to increasing interior smoothness, the welding materially affects the flexibility of the line. Riveted joints in the original line had sufficient flexibility so that anchor blocks on vertical and horizontal angles were not needed nor was there need for special protection at the transition structures between steel and concrete at both ends of siphons. This flexibility is not present in a welded steel line and anchor blocks not previously used are put in during reconstruction at vertical and horizontal angles to hold the welded line in place.

Removal of thin-metal sections of Jawbone Siphon. In background are new pipe sections and a part of the siphon that traverses a 35-percent grade.

Interiors of all pipe sections are coated with coal tar enamel at the fabrication plant except at the ends of the sections where welding would melt the coating. Here the same coating is put on in the field after welding. Exterior surfaces exposed to the weather receive a shop coat of synthetic red lead enamel, a shop coat of synthetic white enamel and a finish coat of aluminum paint.

Except for specials and angles, the pipe was fabricated in 30-ft. lengths weighing about 8 tons. The most difficult part of the operation was reconstruction on the Jawbone Siphon which traverses slopes up to 35 deg. in a particularly rugged terrain. At this site work was started simultaneously at both ends of the old riveted line that was left in place. As the new pipe was installed, water level in the siphons was raised and kept as close as possible to the new work.

The work on the three siphons done last fall was completed, as scheduled, by the J. F. Shea Co. Plans and specifications were prepared under the supervision of H. A. Van Norman, chief engineer and general manager, Bureau of Waterworks and Supply, Los Angeles, under jurisdiction of the late J. E. Phillips, engineer in charge.



After almost 30 years of service lengths of thin, riveted pipe are removed and replaced by ⅜-in. all-welded sections.

N. Y. Daily News photo

Designed to house the offices of municipal government, this new Borough of Queens hall costing $1,990,000 was constructed in nine months. Structural steel totaling 1,930 tons erected in 40 days.

On Schedule and Within the Budget

E. J. McGrew, Jr.
Deputy Commissioner, Department of Public Works
City of New York

***Contents in Brief**—Centralization of authority during planning and careful coordination of field operations result in the construction of the new hall for the Borough of Queens in eight months and within the cost estimate, setting a record for municipal building construction for the City of New York. Functional design, with minimum of embellishment, provides structure at cost of 45c. per cu. ft., including all engineering and architectural costs. Successful plan for budget control established.*

THE ONLY BUILDING built by the City of New York which has been completed within the originally scheduled time or budget of cost, according to available records, is the new $1,990,000 structure which houses the offices of the Borough of Queens. The structure, of 3,736,000-cu.ft. volume, was completed in nine months at a cost of 45c. per cu.ft., including engineering and architectural costs. Notable features of the municipal building project include the attention given to functional design, the centralization and coordination of supervision in the interests of speed and economy, and the system devised for administrative cost control. The structure is located at the intersection of Union Turnpike and Queens Boulevard and brings together for the first time under one roof the many offices of the borough which have been occupying rented space in several buildings, involving undue costs and inconvenience to the public.

A word of history

Establishment of the Borough of Queens through the charter of 1898, which created the greater City of New York, brought together under one administration innumerable small villages and incorporated towns that had previously maintained some form of local government, and hence many scattered local offices.

In September, 1939, the Board of Estimate appropriated $200,000 for engineering costs and approved the employment of architects for making preliminary studies for a centrally located, adequate and appropriate structure to house the office of borough administration. More than a year was occupied in the final selection of a site and this period was utilized in making preliminary studies as to the space requirements for the structure. The following budget provided funds in the amount of $1,990,000 (previously appropriated engineering costs included) and the project was approved for construction.

The carrying out of the project as described in this article was accomplished in large measure as the result of the efficient organization of the Department of Public Works, operating under the direction of Commissioner Irving V. A. Huie.

Financial considerations

In 1939 the space occupied by the departments which were to be centralized in the new building totaled about 192,000 sq.ft. and reasonable provision for expansion indicated the new structure should provide about 223,000 sq.ft. of floor area. As the basis for demonstrating financial feasibility the plan provided that:

the amount to be allowed in the capital budget should not exceed the capitalized savings in rent, after deducting estimated operating expenses of the new building. These rentals and operating expenses in the former quarters total $192,500, and the estimate of $84,000 for operation and maintenance of the new building left $108,500 available annually for covering interest and amortization in the financing of the new structure. The capitalization of this saving was studied under several methods of financing and the Board of Estimate adopted a conservative course limiting the appropriation to $1,990,000 and fixed the scope of the building as one which would provide adequate space for all agencies contemplated in the analysis, but not to include either landscaping of the site or new office furnishings.

The site, as finally selected, was one of 9¾ acres, at the intersection of Union Turnpike and Queens Boulevard. It slopes from southwest to northeast, having a difference of elevation of nearly 40 ft. from front to rear of the site, and about 20 ft. from front to rear of the building, as finally laid out. These grades were taken advantage of in the planning and were made to be beneficial rather than detrimental.

No consideration is given in this discussion to the financial aspects of the acquisition of the site, as it has no bearing on the design and construction of the building. The size of the site provides immediate parking facilities and space for future expansion; its location provides transportation facilities and public convenience.

Design considerations

Several factors controlled the type and design of the structure selected:

1. Limit of 50c. per cu.ft. for construction and engineering costs.
2. Lease expiration dates of Nov. 1 and Dec. 1, 1940.
3. Type of occupancy.

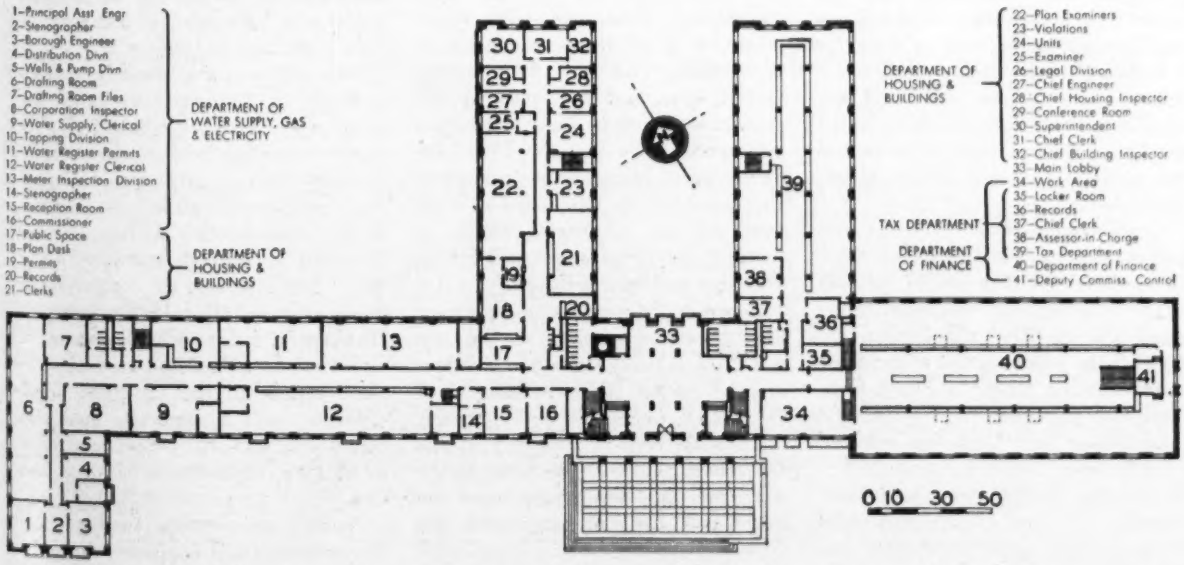
No unusual departures from accepted practice for a structure of this kind were undertaken. Certain principles were, however, adhered to throughout: (1) minimum of embellishment; (2) precise utilization of space by detailed study of space use and of the building dimensions determined by plotting the actual furniture and equipment to occupy the areas; (3) maximum adaptation of similar bays to reduce steel detailing and fabrication time; and (4) simplicity of interior treatment.

The type of occupancy injected peculiar design considerations, several of the departments having heavy public loads, either continuously or at certain periods.

To meet all of these considerations, a building of modified colonial architecture was adopted, 585 ft. long, fronting on Queens Boulevard, with two identical wings, each 150 ft. long, on the north, or rear side of the building, with a colonnaded main entrance at the center of the building at street level. The width of the main building, the wings, and the city collector's, or east wing, were determined by actual plotting of the personnel and furniture to occupy the several spaces, in order that no excess cubage would be created. A maximum of light was obtained by utilizing the contour of the ground and designing a structure of three stories on Queens Boulevard for the main portion of the building and a two-story wing for the city collector's office along Queens Boulevard, but with four stories on the main structure at the rear of the building and three stories at a lower elevation for the two wings in the rear.

Ceiling heights range from 14 ft. 6 in., for the main floor, to 10 ft. for the third floor, for both the main building and the rear wings. The principal operation of the city collector — namely, the collection of taxes — made necessary a room similar to that of a bank, and dictated a higher ceiling fixed at 15 ft. 6 in. Thus, by keeping those departments with a heavy load of public visitors on the ground floor and reducing ceiling heights on upper floors, two things were accomplished; a convenient flow of the public from the main lobby into the various wings and a saving in cubage by reducing ceiling heights as the public load into the building became less on the upper floors.

Utilizing the contour of the ground also made feasible a separate exterior entrance for the collector, the board of elections and a separate entrance on the rear of the building, adjacent



First floor plan indicating the arrangement of the structure to meet functional requirements of municipal departments.

Foundations included 192 spread footings, and a plan for daily inspection and approval of this work kept it in advance of steel erection which involved placing of 1,930 tons in six weeks.

to a projected public parking space for the traffic court. By providing a sub-lobby on the lower, or ground floor level, in the rear of the building, entered from the court formed by the two wings, this separate entrance was arranged for employees or the public who might come by automobile, and it was convenient to the projected parking spaces.

The low buildings also permitted the elimination of passenger elevator service entirely. Every effort was made to bank toilets vertically, in order to avoid long and expensive horizontal runs.

The general layout of the building, its type and utilization of the contours of the ground, probably contributed most to its ultimate economy of construction.

Mechanical details and materials of the best accepted practice for low maintenance and operating costs for a building of the higher grade were followed throughout. All architectural details were thoroughly studied to obtain low construction costs and maintenance and still obtain an esthetic value.

Cross-section of all limestone trim and coping was reduced to the minimum, consistent with proper relation to the building, and variegated limestone was specified throughout, except for the columns and trim of the main entrance, where standard limestone was provided. A low-cost red colonial-type face brick was selected (ASTM Spec. C62-39T, Grade MW). No interior marble trim was used, except in the main lobby and main lobby stair. Wooden fenestration was provided throughout, except in the large windows of the east wing, where steel windows were provided. A minimum of interior partitioning was provided and corridors reduced to 8-ft. 2-in. width on the upper floors.

The exterior wall was made up of one course of face brick with 8-in. back-up tile, waterproofed on the inner face, with a troweled-on mastic damp-proof coating. The interior face of the wall was then finished with a 2-in. tile furring, and plastered throughout. Floor construction was flat-slab cinder concrete, except for ground floor where stone concrete was used to avoid necessity of plastering basement ceiling.

The contract with the architects for preparation of preliminary plans, was signed Nov. 24, 1939. During the month of December, continuous conferences were held with representatives of all future occupants of the building and their floor layouts agreed upon and developed by the architects as each space allocation was settled. By Jan. 2, 1940, the preliminary plans were completed and approved by the Board of Estimate and the architects awarded a contract for preparation of working drawings and specifications.

Contract drawings and specifications were completed during the month of January, with all problems arising during the development of the design settled daily by conferences with various members of the department and the architects, to the end that the department and the Board of Estimate approved the plans and specifications and estimates of cost on Feb. 1, 1940. One week was required to obtain approvals of the department of water supply, gas and electricity, the department of housing and buildings and to print the specifications. The advertisement for bids commenced Feb. 9, 1940, and on March 1 contracts were awarded and the contractors ordered to proceed, with contract completion time set for Oct. 19, 1940.

On the date of bidding, the *Engineering News-Record* "Construction Cost Index," which is employed regularly by the department in controlling design cost, stood at 238.32. The contracts are indicated on the accompanying tabulation covering the budget.

The large number of separate contracts into which the project was divided, and the resultant broader competition of bidding obtained, was undoubtedly responsible for lowering the cost of the building. This practice is, however, neither recommended nor followed by the department, as a general policy, because of (1) the increased problems of administration and control introduced; (2) the greater difficulties of coordination during construction; and (3) the more complex problem of avoiding claims from contractors, which, if later allowed, may easily more than offset the apparent initial advantage of low cost due to competition. On this project, however, all of the first nine contracts completed, have been closed out and final payments made, without any claims, by compromising all disputed questions in conferences between the contractor, the department and the comptroller, an unusual practice not ordinarily followed on New York City contracts.

This policy of conference and compromise in no way abrogates the audit power given the comptroller by charter, and has been made possible only by the sympathetic understanding and cooperation of former Deputy Comptroller Arthur V. McDermott, Deputy Comptroller Alvin McK. Sylvester, and the comptroller's chief engineer, Harold F. Traband. However, if followed in the future, it will tend to reduce the cost of contract claims to the city and legal expense, both to the city and the contractor, and will reflect favorably in ultimate construction costs to the city.

Aside from overtime employed by the architects and engineers throughout the design period, three factors

contributed most to reducing the time normally required for the design of a building of this size and character:

1. Conference method of determining functional requirements during preparation of preliminary plans, by continual conferences with representatives of departments to occupy the building, saving at least two months.
2. Prohibition against changes of layout or program after approval of preliminary plans and during development of final plans.
3. Continuous conferences with the architects and engineers right in their drafting rooms, to settle immediately all questions of policy and differences of opinion on proposed design.

These latter two factors saved an additional three months.

The previous practice of the department had followed a system of interpretation of requirements and policy to architects largely by letter, with little review of the design until developed in its final stage. This method had made for delays on the part of the architect awaiting information, delays from continuous changes and duplication of effort by department technicians in reviewing plans.

Previous experience of the department indicates that, largely because of red-tape and indecision, a structure of this magnitude would rarely be designed and approved under six to eight months. The conference method, prohibition against changes in design and immediate decisions, reduced the time in this case to three months.

The bureau of public buildings of the department will maintain and operate the building. Consequently, the design was reviewed in detail, as it progressed, by A. H. Morgan, director of public buildings and members of his staff, and their suggestions were considered to obtain a layout adaptable to efficient operation and maintenance. This resulted in actual operating and maintenance cost of $80,000, on the basis of the first two months of occupancy, as compared with the original estimate of $84,000.

Construction considerations

Construction commenced Mar. 5, 1940. The resident engineer for the department was given full responsibility and authority over construction in the field. One of the architect's principal assistants during development of design, was assigned as architect's representative in the field office, charged with interpretation of plans and expediting approval of shop drawings and samples.

In early conferences with the contractors, architects and engineers, it was decided to operate the job in three separate sections and a detailed progress schedule was developed for each section with all elements of general construction indicated thereon, the mechanical construction being carefully coordinated to this main schedule by means of sub-schedules set up in the field office.

The first job meeting was held Mar. 14, in the field office, and the job procedure was fixed, which was followed closely throughout. Each contractor agreed to have a principal or agent present with full responsibility for making decisions and commitments for the company. The architect, his consulting engineers and the writer were also present at each meeting.

Contractors were admonished to submit all shop drawings and samples sufficiently far in advance for approval and fabrication in time to meet the schedule.

At all times, the minutes of the weekly job meetings were transcribed on the same day and distributed by the next day. These minutes included a list of all shop drawings, details and approvals awaiting decision and no one was allowed any peace or indulgence in temperament until the imperative items were cleared.

The general contractor, from the

DEPARTMENT OF PUBLIC WORKS, CITY OF NEW YORK
Capital Budget Control

Project: New Borough Hall, Queens
Location: Queens Blvd. at 82nd Ave., Queens
Cubage: 3,736,000 cu. ft.
Unit cost: 41c. per cu. ft. for const. excl. engineering
45c. " " " const. and eng.

Month ending Jan. 30, 1941

Total Estimated Cost as shown in Capital Budget $1,990,000

Appropriations: July 13, 1939 ..... $14,100
Sept. 28, 1939 200,000
Feb. 2, 1940 1,775,000
Total $1,990,000

(A) Project Control Estimate of Cost		(B) B. of E. Resolution Approving Plans-Specs. Est. of Cost		(C) Contracts Awarded		Contract Ceiling "B" or 5% Above "C" Whichever is Less	Total Project Encumbrance (C + Change Orders)	Project Control Balance (A − C + Change Orders)
Project item	Estimate of cost	Date	Amount	Contractor	Contract price			
General Construction	$894,938.54	3/ 1/40	$856,600.00	O'Driscoll & Grove	$856,600.00	$899,430.00	$894,938.54	
" " (Bronze Doors)	14,026.32	6/20/40	15,000.00	O'Driscoll & Grove	14,026.32	14,727.64	14,026.32	
Structural Steel	153,523.24	2/ 1/40	171,000.00	Harris Struct. Steel Co., Inc.	153,000.00	160,650.00	153,523.24	
Plumbing	80,312.87	2/ 1/40	140,000.00	R. T. Frye & Co., Inc.	76,745.00	80,582.25	80,312.87	
Heating & Ventilation	125,490.15	2/ 1/40	180,000.00	J. H. Bodinger Co., Inc.	129,794.00	136,283.70	125,490.15	
Electrical Work	101,241.74	2/ 1/40	110,000.00	Charles F. Zweifel & Co.	96,450.00	101,272.50	101,241.74	
Elevator Work	18,562.13	2/ 1/40	17,000.00	Atlantic Elevator Co., Inc.	18,498.00	19,422.90	18,562.13	
Lighting Fixtures	23,036.65	6/13/40	24,000.00	E. J. Electric Inst. Co.	22,395.00	23,514.75	23,036.65	
Metal Equipment	57,208.30	2/ 1/40	85,000.00	Watson Mfg. Co., Inc.	54,956.00	57,703.80	57,208.30	
Linoleum & Rubber Tile	29,512.62	2/ 1/40	30,000.00	Strawbridge & Clothier	30,320.00	31,836.00	29,512.62	
Painting & Finishing	25,710.00	2/ 1/40	35,000.00	John F. Foster, Inc.	24,480.00	25,704.00	24,745.50	$964.50
Window Deflectors & Blinds	6,100.00	12/19/40	7,500.00	Artistic Venetian Blind Co.	5,784.00	6,073.20	5,784.00	316.00
Moving	16,235.00	9/12/40	25,000.00	Auto Van & Warehouse Corp.	15,461.00	16,234.05	15,461.00	774.00
Landscaping	110,500.00	9/26/40	108,000.00	The Waltham Corp.	105,240.75	110,502.79	107,450.75	3,049.25
Furniture	100,000.00	8/30/40	63,500.00	Various contracts O M O		100,000.00	100,000.00	
		10/10/40	13,000.00	N. Y. W. F. Furniture				
		10/10/40	19,400.00	Purchase or N. Y. W. F.				
Laboratory Equip	14,500.00	12/12/40	13,500.00	Laboratory Furniture Co.	13,800.00	14,490.00	13,800.00	700.00
Contingencies	35,455.44							35,455.44
Architects Fees	101,547.00	9/28/39	19,900.00	William Gehron and Andrew J. Thomas	101,547.00		96,000.00	5,547.00
		1/ 2/40	81,647.00					
D. P. W. Design	19,000.00							
D. P. W. Const. Supervision	39,000.00	9/28/39	69,900.00	Payrolls to Dec. 31, 1940			50,550.70	10,115.95
D. P. W. Supplies, etc	10,000.00						7,333.35	
Equipment	14,100.00	7/13/39	14,100.00	Various Vendors	14,100.00		14,100.00	
Total	$1,990,000.00						$1,933,077.86	$56,922.14

Remarks: Contracts change orders were: added $265.50 for John F. Foster, Inc.
$2,210.00 for The Waltham Corp.

beginning, was charged with setting the pace to meet the schedule; the mechanical contractors with meeting this pace. At no time did one seriously impair the other. Rigid, but commonsense inspection was assured throughout; for illustration, no calipers would be applied to prescribed brick joints, though full buttered and tooled joints would be expected.

From the start, it was realized that the foundation and steel were the critical elements of the construction schedule. The foundation consisted of 192 spread footings, ranging from El. 39 for the bottom of the lowest, to El. 62 for the highest. Footing completion kept up with the schedule of steel erection at all times,—largely on account of the prompt approval of all foundation conditions by the building department through a cooperative policy of permitting the building inspector to visit the job daily as the first order of business.

Detailing of the 1,930 tons of steel started immediately after award and was checked progressively by the structural engineer and released for fabrication. Erection of steel started on Apr. 22, and was completed on May 31.

Several expedients, however, contributed materially to the ultimate early completion of the job:

A considerable quantity of fixed metal equipment was required in the design to meet the functional needs of the departments. Normal construction practice would have dictated that the metal equipment manufacturer hold up fabrication until finished surfaces were completed and exact job dimensions were verified. However, we detailed all metal equipment, guaranteed dimensions and ordered the manufacturer to proceed with fabrication well in advance. By this method, equipment was installed almost immediately after plaster or tile work was completed. The general contractor worked to these guaranteed dimensions and in the end negligible cutting and patching were required. This, alone, saved two to three months in completion date from normal practice.

Installation and testing of risers and branch lines on plumbing and steam circuits by sections and floors saved an indeterminate, but appreciable time and required full cooperation and considerable extra work on the part of those contractors.

These illustrations are typical of principles rather than the details followed throughout the construction period.

At no time was the legal right of a contractor violated, and only once did a contractor deem it necessary to proceed under protest, and this incident was disposed of satisfactorily to all concerned by compromise.

Moving into the building was started Oct. 7, and completed for all agencies from leased quarters before Dec. 1, 1940. Substantial completion for all contractors was accomplished on time, conferences to settle disputed questions held and final payments progressed to the comptroller before Jan. 15, 1941.

Financial control

The creation of the Department of Public Works, under New York's new charter in 1938, introduced a problem of project control with its program of seventy-odd projects in buildings alone, aggregating approximately one hundred million dollars. The prescribed accounting methods of the city were not and are not adequate to give proper financial control, either during design or construction, to a multiplicity of projects such as the department currently handles. Hence, after exhaustive study, the "Capital Budget Control", as illustrated, was finally adopted and put into practice for the first time at the beginning of a project on the new Queens Borough Hall.

Few agencies, either public or private, are confronted with the problem of control of as large a number of diversified projects as the Department of Public Works of the City of New York. Control of either design or construction costs is notably lacking. This method is an attempt to control both. Basically, it starts with a careful budgeting of the project in advance and its subsequent control through all stages of design and construction, to the end that structures may be designed and constructed within predetermined budget limits.

It has worked so successfully in this project that it has been adapted to mechanical accounting methods and adopted as standard in the department for all projects.

Control was so carefully exercised throughout on this project that about $100,000 of new furnishings and over $100,000 of landscaping have been provided out of the original funds that contemplated neither.

In the end, the building is constructed at 3,736,000 cu. ft., and with all contracts either closed out, or in the case of the remaining two building construction contracts, the final cost estimated within narrow limits, the cost of construction, only, is 41c. per cu. ft., and including all engineering and architectural costs, 45c. per cu. ft.—or $6.65 per sq. ft. of area. The old Tweed Court House cost $81.82 per sq. ft.

The design time was three months; construction to substantial completion, eight months.

In my experience, neither speed of design nor economy of construction will be accomplished where many agencies or individuals must be consulted for approvals or direction of policy, but will be accomplished in proportion to the degree that decisions on policy during design and construction are centralized and field responsibility and decision decentralized in competent hands.

And, finally, as far as can be determined from available records, this is the only building ever built by the City of New York, either within the originally scheduled time or budget of cost. The principles adopted may well, therefore, be employed in the future. They are: a maximum of consideration to the functional in design, a minimum of unnecessary embellishment, consistent with dignity, a maximum of centralization of decision and a minimum of change after layout was set.

Organization

Irving V. A. Huie is commissioner of public works for the City of New York and the writer is deputy commissioner in charge of buildings. William Gehron and Andrew J. Thomas, associated, were retained as architects for the projects, and Walter J. Detman was assigned as supervising architect for the department, to handle matters of liaison. The architects retained Matthew Hiller as structural engineer, Sullivan A. S. Patorno as mechanical engineer and, later, C. C. Coombs as landscape architect. William Wessel was the architects' representative in the field office. Carl A. Peterson was resident engineer for the department.

General contract was carried out by O'Driscoll & Grove, New York, with Philip H. Grove, vice president, as project manager, and Fred Garland, superintendent.

Underwater Soil Samples Taken by Portable Test Rig

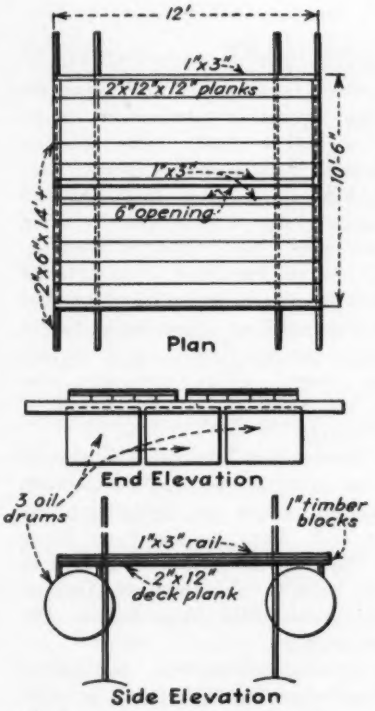
W. H. Jacobsen
Chief of Party, California State Division of Highways

A METHOD affording considerable cost saving in subaqueous exploration and in taking soil samples at bridge sites, developed by the bridge department of the California Division of Highways, is now used on 90 percent of this kind of work in place of the usual heavy equipment. The new equipment is so light and compact that it can be added, without overloading, to the tools ordinarily carried in the light automobiles furnished survey parties.

The outfit is built up around the 1-in. soil sampling tubes developed by the testing and research laboratory of the department. The technique in the use of these tubes has not been changed except that the bridge department has added power driving equipment and some other accessories; the novelty here described consists in the adaptation of soil sampling requirements to a simple and easily assembled raft or float. Details of the soil sampling tubes and the methods of using them were described in *ENR*, June 4, 1936.

A satisfactory raft can be constructed from materials available in almost any small community. A design for such a raft with a 10 x 12-ft. deck supported on six 50-gal. oil drum floats is given in the accompanying drawing. Such a raft will support three men and 300 lb. of equipment. As a lifting pull of 2,000 lb. or more is sometimes required to withdraw the soil tube from the hole after the samples have been taken, it was not practicable to depend upon buoyancy in this operation. A better plan was found in the use of pipe spuds or stands, one at each corner of the raft. At first 4 x 4-in. timber spuds were tried but their small end area gave insufficient bearing on the river bottom and their buoyancy made them hard to handle. Very satisfactory spuds are now made from 2-in. pipe coupled in 6-ft. lengths and provided, at the bottom, with a steel disc footing, welded on, to increase bearing area. The short lengths facilitate handling and transporting pipe.

The raft is fastened to the spuds by chains passing over the float cradles and over a bolt in each spud. Bolt holes are provided in the spuds at 1-ft. intervals for convenient adjustment to water depth. When the soil tubes are being pulled, the downward force exerted by jacks on the raft is carried to the spuds by the chains and the raft actually becomes a 4-legged platform standing on the river bed.



Details of foundation testing rig.

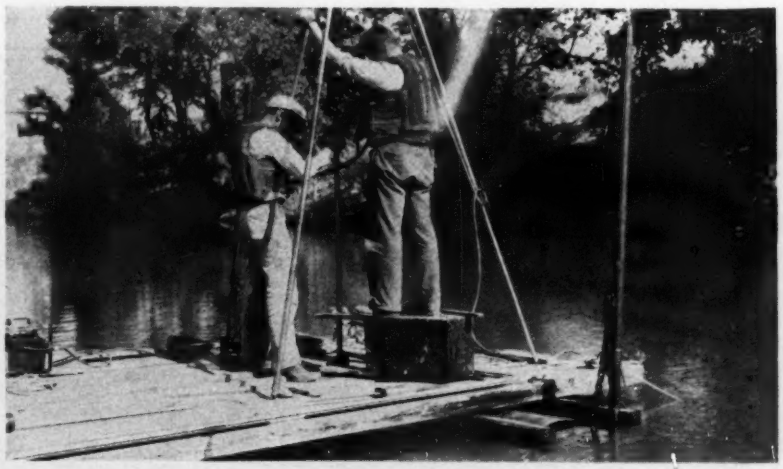
Two types of anchors are used. The side or sway anchors consist of $\frac{5}{8}$-in. eyebolts 3 ft. long welded to metal discs about 1.5 ft. in diameter. These anchors are attached to corners of the raft to prevent lateral drift and yawing. The main anchors holding the raft against the current consist of 3-ft. sections of 10-in. steel I-beams weighing about 120 lb. each.

A steel tripod of 1-in. pipe is assembled on the raft to support the power equipment sometimes needed to drive casings or soil tubes. A 75-lb. portable hammer with gasoline-engine drive is standard equipment for this purpose and is used whenever wooden block and sledge hammer are inadequate.

With the 3-in. casing in place, the soil tubes are put down inside it and when samples have been obtained at the desired depths, are withdrawn by jacks.

Use of this equipment is limited by current velocity and water depth. Thus far satisfactory borings have been made in 14 ft. of water and soil samples have been taken from depths as great as 77 ft. below bottom of the streambed. The total cost of a raft, such as the one shown, complete with spuds, anchors and casing is less than $100.

C. H. Purcell is state highway engineer. The bridge department is under the supervision of F. W. Panhorst, bridge engineer.



Putting down the test tube. Note chain for supporting platform on spuds during jacking. Power-driven hammer is supported on pipe tripod.

Hydraulic Turbines Displayed At Iowa Research Institute

E. W. Lane

Associate Director in Charge
Iowa Institute of Hydraulic Research, Iowa City, Iowa

THIRTEEN DIFFERENT DESIGNS of hydraulic turbines showing various stages in the development of this machine are displayed in the collection of the Iowa Institute of Hydraulic Research, Iowa City, Iowa, as shown in the accompanying illustration. The collection was made by the late Prof. Floyd A. Nagler, director of the Iowa Institute of Hydraulic Research from 1931 to 1933 and was mounted with the help of the WPA. Movable parts have been painted aluminum, while stationary parts are black. With one exception, all of the wheels are of the American or mixed-flow type.

Competition between the early turbine builders was keen. Their advertising claims were often exaggerated beyond reason, and they did not hesitate to make sarcastic comments concerning the wheels of their competitors. It is interesting to read the old turbine catalogues and the test reports of James Emerson, who constructed and operated the Holyoke testing flume. The following paragraph serves as an illustration of the unsettled conditions during the early days of turbine design.

Efficiencies up to 175 percent were claimed for the Wynkoop Water Wheel, patented in 1866, which consisted of two wheels, one above the other, operating together by means of a hollow shaft. After passing through the top wheel, the water was used by the bottom wheel, the full energy of the water supposedly being used twice. When tested by Emerson, the best efficiency was found to be 55 percent. Many persons had testified to the soundness of the design theory before the wheel was tested, including several college professors, one at the head of a state board of education.

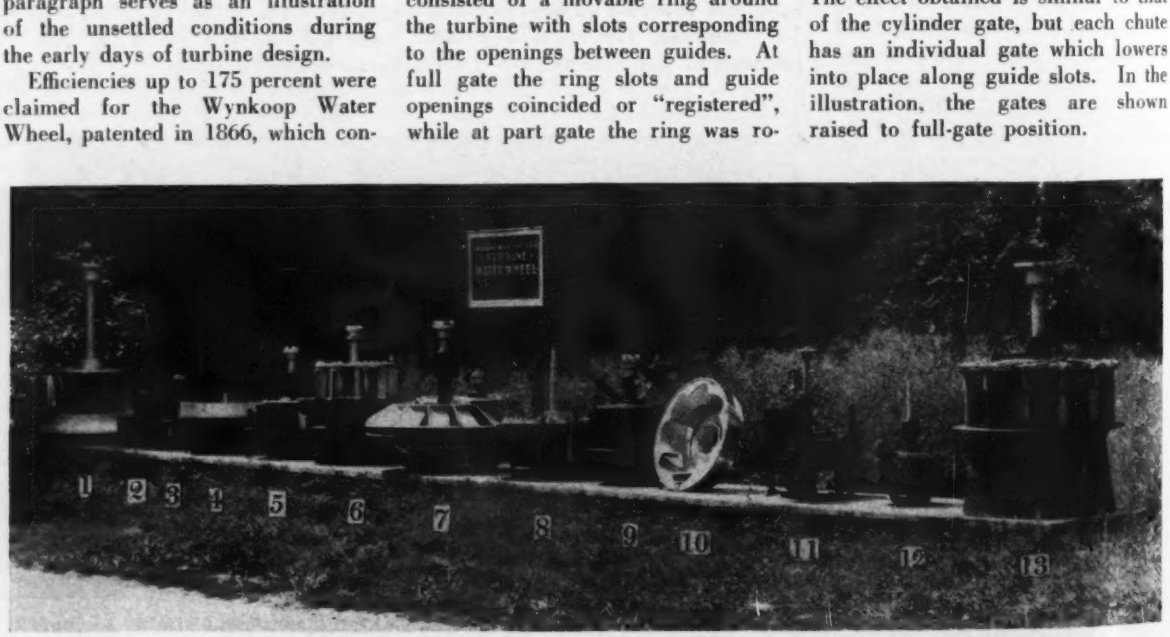
Runner No. 1 in the collection is from a 51-in. vertical McCormick Turbine, which was operated under an 8½-ft. head on the Iowa River at Iowa City from 1906 to 1916, and was built by the Dubuque Turbine and Roller Mill Mfg. Co. at Dubuque, Iowa.

Definite information is lacking about wheel No. 2, but it appears to be a 20-in. Risdon type with inside register gate. The register gate was commonly used during the development of the American wheel and consisted of a movable ring around the turbine with slots corresponding to the openings between guides. At full gate the ring slots and guide openings coincided or "registered", while at part gate the ring was rotated so that only a part of each slot was opposite each guide opening. James Emerson in 1879 credited the Risdon wheel at full gate with the highest efficiency of any tested. At part gate, however, the efficiency dropped off rapidly, so that it was not as practical for most installations as were other designs of the American type.

Wheel No. 3 is an "Old Reliable Standard", first patented by James Leffel in 1862, and manufactured for many years essentially without change by James Leffel and Co. The 23-in. turbine with wicket gate in the collection came from the Wilson Mill near Sterling, Ill.

An example of a cylinder gate type, 36-in. dia., is shown by wheel No. 4, which was installed in a mill at Morrison, Ill., in 1850. Wheel No. 5, 36-in. dia., is an original "American Turbine" manufactured under that name by Stout, Mills, and Temple of Dayton, Ohio. Patented in 1859, it was known also as the Dayton wheel and had the gates and chutes cast in one piece, pivoted at a point near the wheel resembling in some ways a wicket gate. This wheel was considered by James Emerson to be the best of the early types before 1876. It had a high efficiency at part gate which Emerson rightly considered to be more important than efficiency at full gate.

Wheel No. 6, 32-in. dia., is unusual with respect to the gate mechanism. The effect obtained is similar to that of the cylinder gate, but each chute has an individual gate which lowers into place along guide slots. In the illustration, the gates are shown raised to full-gate position.



Old hydraulic turbines on display at the Iowa City laboratory show many stages of turbine development.

A 35-in. Houston with register gate, patented in 1870 and manufactured by Merrill and Houston Iron Works, Beloit, Wis., is wheel No. 7. This wheel was used at Clear Lake, Iowa, from 1875 to 1892. Although the efficiency was good at full gate, it dropped off rapidly at part gate. The 21-in. modern Zowski turbine with wicket gates, No. 8, manufactured by James Leffel and Co., produced 134 hp. under 16-ft. head. These wheels have been notable for their high efficiencies.

The 25-in. Victor wheel with register gate, No. 9, manufactured by Stilwell and Bierce of Dayton, Ohio, was described by James Emerson as being the lowest-priced wheel of comparable efficiency of its time, mainly because of its simple construction. Emerson believed that the Victor and Hercules turbines would eventually supersede all other types.

The 47-in. runner, No. 10, is from the old Terrill Mill, one of the oldest water-power developments in Iowa, built at Iowa City in 1841. It is of the outward-flow type and was probably manufactured by a foundry in Muscatine, Iowa. The wheel was placed over an opening in a timber floor, no draft tube or guides being provided. It was installed with a log shaft and wooden step bearing, and drove one run of stone under 5-ft. head, producing about 15 hp. Wooden blocks were wedged into some of the openings when it was desired to decrease the discharge.

An early scroll-case design, 24-in. dia., is illustrated by No. 11 and is very similar to those manufactured by John Tyler of Claremont, N. H., whose scroll wheels Emerson believed to be the best produced. A drop gate at the entrance to the scroll was used to control flow.

The 18-in. Lesner turbine with register gate, No. 12, came from a mill at Voorheesville, N. Y., and was presented by Robert E. Horton. This wheel was first patented in 1872 and was manufactured by Wemple's Sons, Fultonville, N. Y. From their catalogue: "It is so compact and plain that its merits are almost obvious at a glance . . . This is one of the most economical, powerful and durable wheels known."

Wheel No. 13 is a 35-in. Standard Samson Turbine with wicket gate, which evolved from the Old Reliable Standard (No. 3), both manufactured by James Leffel and Co.

In addition to the above wheels, the collection also contains two 40-in. French burr stones, mounted on either side of the entrance to the laboratory, which were used about 1865 in a mill north of Iowa City. An old wooden water wheel, about 5 in. thick and 26 in. in diameter, in use before the Civil War in the Great Smoky Mountains near Robbinsville in western North Carolina, completes the collection.

Vibration Periods at Tacoma Narrows

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***Contents in Brief**—Difficulties in calculating vibration periods of such complicated structures as suspension bridges may be overcome by using simplified equivalent mass systems for bridge elements. By such process the observed periods for the Tacoma Narrows bridge for both vertical and torsional oscillation are calculated with reasonable accuracy.*

MOST DISCUSSIONS of the failure of the Tacoma Narrows suspension bridge agree that aerodynamic instability of the floor system was a very important factor in exciting certain modes of vibration, one of which led to the destruction of the bridge. Although any exact mathematical solution for the natural periods of such a complicated structure would be impossible, it is possible to make an approximate calculation for these periods.

As an example, take the two modes of vibration referred to by T. C. Rathbone (*ENR*, Dec. 5, 1940, p. 40). Mr. Rathbone's statements referring to these two vibrations will be repeated to refresh the reader's memory:

"Prior to Nov. 7 the girder motion was vertical and undulating, both sides of the girder moving up and down in unison, but the span oscillated in two loops with a node at midspan, the portions on" (opposite ends of the span) "either side moving in opposite phase. The period of this motion was reported to be about 12 sec.

"On the day of the collapse, the mode of motion started off as usual, but rather suddenly the twisting mode developed, the sides of the girder moving up and down in opposite phase, as well as the two halves of the main span, with a faster period of about 4 sec."

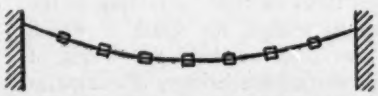


Fig. 1. For vertical oscillation studies bridge may be simulated by a cable whose mass also includes the mass of the floor system.

The first mode represents an up and down oscillation, while the second represents torsional oscillation. Considering the up and down oscillation first, the flexural rigidity of the floor by itself, which is very small, will be negligible. Also towers will be assumed to be rigid. Under this condition the bridge span will simulate a flexible cable with a mass equivalent to the combined mass of the cables and floor. This is shown in Fig. 1. Any disturbance along the span will now travel along this equivalent cable with a velocity equal to

$$v = \sqrt{\frac{T}{m}}$$

where T = tension in the cable

m = mass per ft. of span

The period γ for one cycle is obtained by dividing the distance traveled by the wave by the velocity

$$\gamma = \frac{2l}{v}$$

To illustrate with numerical results, the following calculations are shown:

The weight (w) of the floor system per ft. per cabe is

floor $= 110 \times \frac{39}{2} = 2{,}150$ lb.

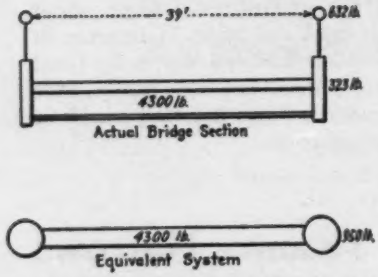


Fig. 2. For torsional oscillation studies bridge cross-section may be replaced by the equivalent mass section shown.

stiffening girder = = 323 lb.

weight of cable = $\frac{\pi}{4} \times \left(\frac{17}{12}\right)^2 \times 0.82 \times 490 =$ 632 lb.

w = 3,105 lb.

$$T = \frac{wl^2}{8d} = 3105 \times \frac{2800^2}{8 \times 232} = 13.1 \times 10^6 \text{ lb.}$$

where l = span length = 2,800 ft.
d = max. sag = 232 ft.
w = wt. per ft. per cable = 3,105 lb.

$$m = \frac{w}{g} = \frac{3,105}{32.2} = 96.4 \frac{\text{lb. sec.}^2}{\text{ft.}^2}$$

$$v = \sqrt{\frac{13.1}{96.4}} \times 10^3 = 369 \frac{\text{ft.}}{\text{sec.}}$$

$$\gamma = \frac{2 \times 2800}{369} = 15.2 \text{ sec.}$$

Although a number of approximations were made, the results are not too far from the observed 12 sec.

Considering the second or torsional mode of vibration, the structure represents three distributed systems in series, the tower, the cables and the floor. These cannot be represented by the simple spring mass system in series since the differential equation for the vibration of a distributed system is different from that of a system with concentrated masses. The torsional oscillation of a uniformly distributed structure can, however, be represented by the following partial differential equation:

$$m^2 \frac{\delta^2 \theta}{\delta x^2} = \frac{\delta^2 \theta}{\delta t^2}$$

where

$$m = \sqrt{\frac{c}{J}}$$

c = torsional stiffness $\frac{\text{ft. lb.}}{(\text{rad. ft.})}$

J = polar moment of inertia per ft.

$$\frac{\left(\frac{\text{lb.}}{\text{ft.}}\right) \text{sec.}^2}{\text{ft.}} \times \text{ft.}^2 = \text{lb. sec.}^2$$

θ = angle of twist in radians

For a narrow bridge of the type under consideration the torsional stiffness of the floor by itself is small in comparison to the torsional stiffness of the cable, and can be neglected. Here again the towers will be assumed rigid. The effect of the cables then is to introduce a torsional stiffness to the floor and give it added mass along the edge.

The torsional stiffness of a pair of cables under a tension T is:

$$c = T b^2$$

where b is the distance between cables. Incorporating this into the floor system, the actual bridge section can be reduced to the equivalent system shown in Fig. 2 which has a torsional rigidity of $T b^2$.

The following calculations afford a numerical example:

$$c = Tb^2 = 13.1 \times 10^6 \times 39^2 = 19,900 \times 10^6 \text{ lb. ft.}^2$$

Polar moment of inertia $J = \sum \frac{w}{g} k^2$

for distributed load of floor $= \frac{4,300}{32.2} \times \frac{39^2}{12} = 17,000$

for girders and cables $= 2 \times \frac{950}{32.2} \times \left(\frac{39}{2}\right)^2 = 22,400$

The total J = 39,400 lb. sec.^{2}

With a node at the center of the span, the solution for the differential equation becomes

$$\theta = A \text{ Sin } \frac{2\pi X}{l} \text{ Sin } \frac{2\pi}{\gamma} t$$

and the period $\gamma = l \sqrt{\frac{J}{c}}$

$$= 2,800 \sqrt{\frac{39,400}{19,900}} \times 10^{-3} = 3.94 \text{ sec.}$$

This period corresponds to the observed 4 sec. for the torsional oscillation.

The fact that the torsional stiffness of the bridge varies as the product of the cable tension and the square of the distance between cables, indicates that most bridges are at least eight times as rigid in torsion as the Tacoma bridge, the width of which is less than one-half the width of most suspension bridges of comparable size. Under such circumstances the Tacoma bridge is unusual in design, presenting difficulties otherwise not encountered in wider bridges.

Concrete and Pipe-joints Studied at Armour

Among the diverse activities of the Armour Research Foundation of Chicago are the development of a jointing compound for clay-pipe sewers and the production of a light-weight concrete suitable for low-cost housing construction. These studies, along with many others, are noted in the annual report of Harold Vagtborg, director of the Armour Research Foundation.

Pipe-joint Compound — At the foundation laboratory, the Clay Products Association has promoted a study for the purpose of developing a compound which, besides being economical and practicable, will meet the various requirements. It must be permanently watertight and thus afford no access for tree roots; it must adhere to wet, dry, muddy or greasy pipe; it must not shrink, harden or become brittle, and it must resist the action of the numerous acids and alkalies that may be present in the sewage. The new composition, which is said to meet many of these conditions, is melted in an open kettle and is poured at a temperature of 250 to 450 deg. F., with the usual form of runner.

This material, as described in the report, was developed particularly for sealing the joints in making house connections to sewers, as this is the place where tree roots have caused the greatest trouble. It is expected to be useful also on main sewers and outfall lines, where leakage would be a hazard to public health. Accelerated field tests are being made in California, where fast-growing trees are available, and where the slightest leakage has an attraction for the roots. A test is also under way in a Chicago greenhouse, where joints may be subjected to continuous tests for leakage and the penetration of plant roots.

Light-weight Concrete—One of the studies in the thermal insulation laboratory has been the development of light-weight concrete that would be suitable for low-cost housing construction, and must therefore combine low-heat conductivity with ample bearing strength. It is considered that a building wall of light-weight concrete blocks, with plaster applied directly on the inside, will give results comparable with an ordinary dwelling-house wall.

U. S. Army Air Corps photo

Sewage treatment plants at Army camps are designed to recommended standards, modified to meet local conditions. Progress is shown on the activated sludge plant at Camp Shelby, Mississippi.

Sewage Treatment for Army Camps

***Contents in Brief**—Recommending good practice in methods of sewage disposal adapted to the special conditions prevailing at Army camps was the task assigned to the consulting engineering firms of Metcalf & Eddy and Greeley & Hansen. The following is an abstract of the principal recommendations made in their joint report to the War Department.*

RECOMMENDATIONS for the design and installation of sewage treatment facilities at Army camps, made jointly by the consulting firms of Metcalf & Eddy and Greeley & Hansen, provide specialist information on sanitation activities in the national defense program. These consulting engineers, under a contract with the War Department, were authorized to "advise and report as to the simplest sewage treatment plant at each project suitable and adequate to meet the minimum requirements under local conditions."

The following excerpts are taken from this report.

The size of the camps as measured by the personnel is from 1,500 to 66,000, with the majority having from 20,000 to 30,000 troops. The average quantity of sewage at camps and cantonments is estimated by the Construction Division of the Quartermaster General's office to be 70 gal. per capita per 24 hours. This is a reasonable quantity of sewage, perhaps high rather than low. Although most of the 70 gal. may be discharged during 16 hours, all rates are expressed on the 24-hr. basis. The fact that most of the sewage flow may occur within 16 hours has been taken into consideration in the establishment of liberal detention periods based on the 24-hour average flow.

Experience with flow rates at the Army cantonments in 1917–1918 is shown in the accompanying illustration. It is recommended that treatment projects be designed to provide for a maximum quantity of sewage, lasting for several hours, of twice the average quantity, or at the rate of 140 gal. per capita per day. Hydraulics of treatment plants and other affected parts of the design should provide for maximum quantities, lasting for an hour or less of 2.5 to 3.0 times the average, depending upon the size and arrangement of the camp and the steepness of the sewers.

There is very little information regarding the characteristics of sewage from Army camps. However, study of the few published records of sewage analyses from the cantonments in 1917–1918, indicates the following characteristics:

Item	Parts per million	Lb. per capita per 24 hr.
Suspended solids	460	0.27
B.O.D. (5-day)	290	0.17
Ether-soluble matter	150	0.09

The per capita quantity of suspended solids is a good deal higher than is normally found in domestic sewage. This may be accounted for by the adult and male character of the personnel and by the relatively large amount of grease. The per capita quantity of B.O.D. is about the same as that in average domestic sewage but is somewhat higher than often found in residential sewage. The per capita quantity of grease is two to three times that normally found in domestic sewage.

The sewage will, in general, be very fresh, should have good settling qualities and the settled sewage should be readily amenable to treatment by biological processes.

The degree of treatment and the type of sewage treatment plants to

TABLE I—BASES OF DESIGN FOR SEWAGE TREATMENT PLANTS AT U. S. ARMY CANTONMENTS

Recommended by Metcalf & Eddy and Greeley & Hansen, Consulting Engineers

Quantities: Average, 70 gal. per capita per day; maximum (for several hours), 140 gcd.; peak 210 gcd.

Sewage Characteristics: Suspended solids, 460 ppm; B.O.D., 290 ppm; other soluble material, 150 ppm. Per capita per 24 hr. there will be 0.27 lb. suspended solids and 0.17 lb. B.O.D.

Measuring Devices: Parshall flume, rectangular flume, Palmer-Bowlus or Venturi meter.

Grit Chambers: Omit, except in special circumstances. If used, they should be hand cleaned, with disposal by burying.

Bar Screens: Hand cleaned or mechanically cleaned as local conditions indicate. Screenings to be disposed of by burial or by burning in a suitable incinerator. Comminutors or screenings grinders to be employed under some circumstances such as proximity of plant to occupied buildings. Clear space of bar screens, 1 to 1½ in.

Primary Sedimentation Tanks: Displacement period based on average flow. Sedimentation only or ahead of trickling filters 3.0 hr.; in case of high dilution of settled sewage 2.5 hr. may be used. Ahead of activated sludge use 1.5 hr. based on average flow. Ahead of biofilters, based on average flow, use 7.5 hr. for a dilution ratio of 1:1.5 (single-stage filtration) and use 6 hr. for a dilution ratio of 1:1 (two-stage filters).

Trickling Filters: (a) Standard, or low-rate, trickling filters in southern locations with no severe winter—not to exceed 5,000 population per acre-foot. With filters 6 ft. deep, this is 2.1 m.g.a.d. average at 70 gcd. In northern climates loadings should not exceed 4,000 population per acre-foot. (b) High-rate trickling filters to have loads not in excess of some 3,000 pounds of B.O.D. applied per acre-fot, for camps in the south. This is equivalent to a population of 35,000 per acre-foot. In northern camps the loading should not exceed 30,000 per acre-foot.

Final Sedimentation Tanks: Flow not to exceed 800 gal. per sq.ft. per 24 hr., and not less than 2.25 hr. displacement, both based on the average flow, except when following two-stage biofilters with recirculation ratio of 1:1 from the secondary tank effluent to the influent of the second-stage filter, in which case the capacity of the secondary tanks should be doubled. Depth 10 to 12 ft. with some reduction, or increase, in the depth in special cases.

Sludge Digestion Tanks: For plants of the trickling filter type for primary and secondary sedimentation and with heated sludge tanks use 2.0 to 3.0 cu.ft. per capita. For unheated sludge tanks in warm climates, add 25 to 50 percent to the foregoing, using the larger capacities in locations close to occupied buildings. For plants of the activated sludge type, increase the foregoing allowances by 50 percent.

Sludge Drying Beds: In warm climates and where the location permits, drying sludge in lagoons without underdrains or filter material is acceptable with 2.0 to 3.0 sq.ft. per capita. Sludge drying beds with underdrains and filter material are also acceptable. For plants of the trickling filter type the area provided should be 0.5 to 1.0 sq.ft. per capita, and for plants of the activated sludge type this allowance should be increased to 1.0 to 1.5 sq.ft. per capita. The lower unit in each case applies to the most favorable conditions with opportunity for lagooning any excess sludge.

Imhoff Tanks: Sedimentation compartment same as primary sedimentation tanks and digestion compartment same as for unheated separate sludge digestion tanks. In northern climates use for the sludge compartment of Imhoff tanks: With plain sedimentation, 2.0—2.5 cu.ft. per capita, and with plain sedimentation and trickling filters 3.0—3.5 cu.ft. per capita.

be built are indicated by the following major factors:

(1) The character and use of the receiving watercourse or drainage channel.

(2) The general environment both of the treatment plant site and the camp area.

(3) The degree of permanence of the projects.

(4) The need for the utmost speed in the design and construction of the projects.

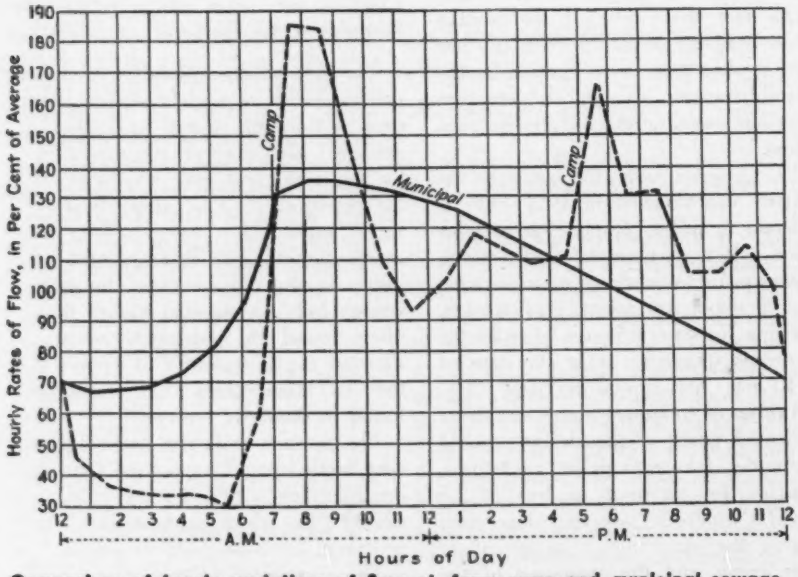
(5) The great need for safeguarding the health of troops and civilian population in the neighborhood.

(6) Reasonable and proper consideration of construction cost and the probability that operating cost will not be so important a factor as in more permanent plants for municipal service.

It is recommended that, with any degree of treatment, adequate provision be made for chlorination of the treatment plant effluents.

Inspection of the camps indicated that so-called complete treatment of the sewage is needed at many of the projects. Where the effluent from the sewage treatment plant is to be discharged into a relatively large stream which has sufficient flow to provide a dilution of about 4 cfs. per 1,000 population, based on the minimum monthly flow, sedimentation tanks with chlorination are generally sufficient. This partial degree of treatment is also suitable in some cases where the effluent is to be discharged into tidal water not used for recreation or shellfish culture in the vicinity, in which case more complete treatment may be required, depending upon local conditions.

In many of the projects so far inspected, plants comprising high-rate trickling filters are underway and



Comparison of hourly variations of flow at Army camp and municipal sewage treatment plants. Sewage flow at camps has two pronounced peaks.

have been approved. The effluent from high rate trickling filters may not be treated to as high a degree as the effluent from standard or low rate trickling filters or from activated sludge. However, considering the temporary character of the projects, the desirability for economy and the possibility of the ample use of chlorination during the few years of service, the degree of treatment accomplished by high rate trickling filters should be sufficient.

Design considerations

A summary of recommended bases of design for the sewage treatment plants is given in Table I. These bases of design are considered desirable, but some departures from them have been approved to expedite construction. Some comments are pertinent.

Sedimentation tanks for preliminary treatment ahead of trickling filters, either standard or aerofilter type, should have a displacement period of 3 hr. based on the average quantity of sewage. Fresh sewage having the expected characteristics will permit relatively large removals of suspended solids and B.O.D., if this period of sedimentation is provided. It is estimated that the proposed basis of design may accomplish the removal of as much as 50 per cent of the B.O.D. Ahead of biofilters which require the recirculation of effluent through the preliminary sedimentation tanks, these tanks must be considerably larger with a displacement period of 6.0 to 7.5 hr. (depending on the recirculation ratio) on the average quantity of sewage. Under some conditions where sedimentation only is used and the volume of diluting water is relatively large a sedimentation period of 2.5 hr. is ample.

The basis of design for trickling filters has been stated in terms of the tributary population per acre-foot. The bases of design stated for trickling filters are relatively high and permit minimum sizes and minimum costs for trickling filter construction. Suitable distributors to provide reasonably uniform application of the settled sewage to the surface of the filters are essential.

The basis of design for final sedimentation tanks, both as to area and depth, is such that the settling rate will not exceed 800 gal. per sq. ft. per 24 hours and the dis-

TABLE II—SEWAGE TREATMENT PLANTS FOR LARGER NATIONAL DEFENSE PROJECTS, 1940

(Compiled from data obtained from the office of the Quartermaster General)

Post	Location	Design basis m.g. per 24 hr.	Type of treatment
Aberdeen Proving Ground	Aberdeen, Md.	1.05	Primary treatment, sludge digestion, chlorination
Fort Belvoir	Ft. Belvoir, Va. (a)	0.21	Primary treatment
	(b)	1.19	" "
Camp Blanding	Camp Blanding, Fla.	3.5	Primary treatment, sludge digestion, chlorination
Fort Bliss	Ft. Bliss, Tex.	2.17	Through El Paso city sewer system
Camp Bowie	Brownwood, Tex.	2.1	Aerofilters, chlorination
Fort Bragg	Fort Bragg, N. C.	4.62	Single-stage biofilters
Camp Claiborne	Alexandria, La.	1.4	Activated sludge, chlorination
Fort Devens	Fort Devens, Mass.	2.1	Sand filters
Camp Dix	Camp Dix, N. J.	3.15	Additions—Trickling filter, chlorination
Camp Edwards	Falmouth, Mass.	2.1	Two-stage biofilters and sand filters
Fort Eustis	Ft. Eustis, Va.	1.12	Primary treatment, chlorination
Galveston Replacement Center	Hitchcock, Tex.	0.7	Biofilters, chlorination
Camp Grant	Rockford, Ill.	0.7	Through Rockford sewer system
Fort Huachua	Ft. Huachua, Ariz.	0.525	Primary treatment chlorination
Camp Hulen	Palacios, Tex.	0.84	Primary treatment, chlorination
Indiantown Gap Reservation	Annville, Pa.	1.54	Sedimentation, trickling filters, chlorination
Fort Knox	Fort Knox, Ky.	3.5	Preliminary roughing filter and secondary trickling filter
Camp Lee	Petersburg, Va.	1.68	Primary treatment, chlorination
Camp Livingston	Alexandria, La.	1.54	Two-stage biofilters
Camp McClellan	Camp McClellan, Ala.	1.54	Trickling filters, chlorination
Macon Replacement Center	Macon, Ga.	1.26	Primary treatment, chlorination
March Field AA Firing Center	Riverside, Calif.	0.84	Single-stage biofilter
Fort George G. Meade	Ft. Geo. G. Meade, Md.	2.1	Primary treatment, probably high capacity filters, chlorination
Fort Monmouth	Ft. Monmouth, N. J.	0.70	Activated sludge and chlorination
Nacimiento Replacement Center	Nacimiento, Calif.	1.75	Biofilter
Camp Peay	Tullahoma, Tenn.	2.0	Aerofilters, chlorination
Pine Camp	Watertown, N. Y.	1.4	Primary treatment, sludge digestion, chlorination
Fort Riley	Ft. Riley, Kans.	...	Primary treatment, chlorination
Camp Jos. T. Robinson	Little Rock, Ark.	2.1	Trickling filters
San Diego Replacement Center	San Diego, Calif.	0.7	Aerofilters, chlorination
Camp Merriam	San Luis Obispo, Calif.	1.4	Trickling filters, chlorination
Seventh Corps Area Training Center	Newburg, Mo.	3.0	Trickling filters
Camp Shelby	Hattiesburg, Miss.	4.2	Activated sludge, chlorination
Camp Stewart	Hinesville, Ga.	1.4	Primary treatment, high-rate filters, sludge digestion, chlorination
Fort F. E. Warren	Cheyenne, Wyo.	0.525	Two-stage biofilters, chlorination
Fort Sill	Ft. Sill, Okla.	2.73	Preliminary roughing filters, secondary trickling filters
Wilmington AA Firing Center	Wilmington, N. C.	1.4	Activated sludge, chlorination
Camp Wolters	Camp Wolters, Tex.	1.4	Two-stage biofilters

At Camp Shelby in Mississippi construction work is being speeded on a 4-mgd. activated sludge treatment plant.

placement period be not less than 2.25 hr., both based on the average quantity of sewage. These bases are considered to be minimum allowances (with no recirculation through the final tanks) and somewhat more capacity is often desirable.

Sludge digestion capacity

Separate sludge digestion tanks are recommended, in general, with equipment for heating the sludge. For complete treatment plants of the trickling filter type, the sludge digestion tanks should provide capacity equivalent to from 2 to 3 cu.ft. per capita. This capacity provides for a rate of about 2.75 pounds of suspended solids discharged into the tank per cubic foot of tank capacity per month, which is a reasonable load. In some cases unheated tanks may be provided in which case heating coils should be installed to permit addition of heating facilities if ever required. In other cases existing multiple-hopper septic tanks may be converted to sludge digestion tanks if they provide not less than 4 cu.ft. (somewhat less may be sufficient in warm climates) per capita of storage capacity. For plants of the activated sludge type, the capacity of the digestion tanks should be increased by 50 per cent or more.

In general, open sludge drying beds with underdrains and filter material are proposed of sufficient area to provide 0.5 to 1.0 sq.ft. per capita. For plants of the activated sludge type, these allowances should be increased to 1.0 to 1.5 sq.ft. per capita. At some of the camps, as for instance those in Southern California, and in similar warm climates, the cost can be reduced by providing sludge lagoons without underdrains or filter material, and with sufficient area to provide 2 to 3 sq.ft. per capita. In the warm climates, at most of the projects, the foregoing upper limits are somewhat liberal.

It is expected that relatively large quantities of scum will be removed from the primary sedimentation tanks. Such scum is usually disposed of either by digestion with the sludge or by burning in a small incinerator. In either case, at the larger camps, piping and pumps will be required for handling the scum. These should be of ample capacity and sturdy construction, with provisions for flushing and rodding. In an emergency, for instance during the cleaning of scum pumps and piping, the scum may be buried.

It is very difficult to estimate the cost of sewage treatment plants for the projects because the haste and other emergency conditions are likely to change the unit costs found by experience in the construction of sewage treatment plants for municipalities. Present indications are that complete treatment plants with high-rate trickling filters may generally be built for from $4.50 to $6.00 per capita, the smaller the project, the higher the per capita cost.

Plain sedimentation, or plain sedimentation followed by trickling filters, and in particular high-rate trickling filters, with provision for ample chlorination, are best suited to the emergency program. Relatively new processes of sewage treatment which have not become sufficiently well established to come into general use should not be considered. The need for rapid design and construction does not permit time for the necessary study of new treatment processes.

Consideration has been given to the question of whether the buildings at sewage treatment plants should be of wooden or masonry construction. If a building at a sewage treatment plant should be destroyed by fire, it would be possible to operate the treatment plant with little loss of efficiency. In the interest of economy and speed, therefore, wooden buildings are recommended. However, adjacent to established Army posts having masonry buildings, the buildings of the sewage treatment plants should also be of masonry construction.

Local requirements

Wherever there is opportunity, the sanitary engineers of the state departments of health should be consulted regarding the type and bases of design of the proposed sewage treatment plants. The recommended bases of design, in most instances, do not differ from established practice. The recommended loadings for trickling filters have been set somewhat high for the following principal reasons: (1) economy; (2) speed of construction; (3) generally favorable climatic conditions at the camps; (4) probable high removal of B.O.D. by preliminary sedimentation; (5) possibility of ample chlorination.

The topography and location of the stream or body of water for receiving the effluent will usually determine the location of treatment plants. Plants should preferably be located as far as practicable from camp buildings, private dwellings and traveled ways. Furthermore, plants should be located where they will not interfere with the military functions of the camp, and should be at a safe distance from rifle and artillery ranges. Protection against floods should be provided.

ELECTRIC DRIVE FOR ORDINARY JOBS—IX

Care of Motors and Controls

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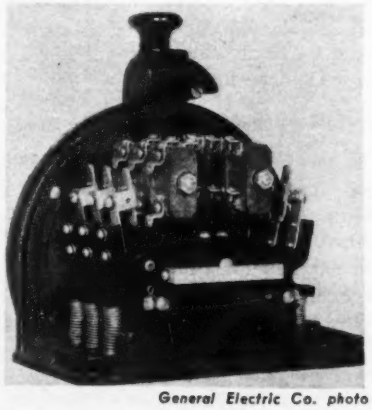
***Contents in Brief**—Last of a series on electrified construction equipment for ordinary jobs, this article emphasizes the necessity of keeping motors and controls clean and dry. Guides for inspection, maintenance, and storage are included.*

HAVING INCURRED a considerable expense in the purchase of electrical equipment for his construction machinery, the contractor naturally desires to obtain from it the longest and most satisfactory service possible. This is secured only by constant care and attention. Construction equipment differs from that employed for industrial purposes in that it is continually being moved from one job to another, and its use is often interrupted by periods of idleness while it is held in reserve awaiting the next job. Storage and putting back in service of electrical equipment requires special attention to get continuing efficient service.

Before any electrical equipment, new or previously used, is placed in operation, it should be given a thorough inspection and the voltage of the motor's nameplate checked with that of the supply. Voltage may vary from that for which the equipment was designed by as much as 10 percent without impairing satisfactory operation, provided the frequency is maintained at that designated. This limit, however, should not be exceeded and the closer the voltage is held to that for which the equipment was designed, the better will be the operation. An increase of voltage will result in decreased power factor, increased torque and decreased slip, while a decrease of voltage will have directly opposite effects. Of the undesirable results, the most important to the contractor is doubtless the decrease in motor torque due to low voltage. Starting torque decreases as the square of the decreased voltage, so that a motor designed for adequate power may fail to start the load if the voltage is unduly low.



General Electric Co. photo

Controller case should be occasionally removed for cleaning and check against spark jumping.

The wiring should also be subjected to a thorough check, particularly all connections between the motor, the controller and the lines. All equipment when purchased is furnished with wiring diagrams which should be carefully preserved for future use. In reinstalling any equipment, the most fertile source of trouble may be looked for in improper connections, especially true where the connections are apparently simple. If the wiring is elaborate and complicated the electrician is very likely to follow the diagrams and get the connections right.

PREVIOUS ARTICLES

Getting Power to the Job — Feb. 1, 1940, p. 164
Selecting the Motor for the Work — Feb. 29, 1940, p. 326
Motors and Controls for Pumps and Compressors — March 28, 1940, p. 442
Dust and Water-Proof Motors for Mixers — April 11, 1940, p. 501
Simple Hoists for Cable Operated Scrapers — May 9, 1940, p. 659
Special Motors and Controls for Cranes — June 6, 1940, p. 805
Small Tools — Jan. 2, 1941

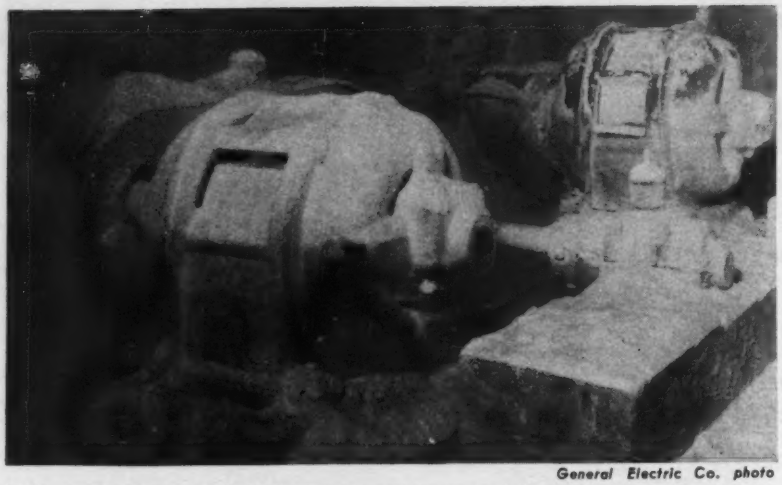
It is of utmost importance in the preliminary inspection to see that both the motor and its control are clean, as many of the troubles experienced with electrical equipment may be traced to ordinary dirt and dust. Yet there is no source of trouble easier to correct. Frames and such exposed parts as are accessible from the outside of the machine may be wiped with a clean dry cloth; the use of waste should be avoided as the lint therefrom will adhere to the insulation and serve as a collector for dust, oil and moisture. The interior of the motors may be freed of dirt by the application of compressed air (it must be free of entrained moisture), at a pressure less than fifty pounds, so that it will not blow dirt into the insulation rather than removing it.

Oil and moisture detrimental

Cleaning of motors and controls must also include removal of all outside oil. Oil leaked or splashed onto the motor shaft is sure to be drawn into the windings where it will eventually cause insulation deterioration.

Moisture is as detrimental to insulation as oil. New machines may ordinarily be placed in operation without previous drying, as the heat generated in the windings will usually drive out what little moisture may have accumulated. Motors exposed unused to the elements for any considerable time, however, should be dried out before being placed in operation.

The simplest method of drying windings on the job is by the use of inexpensive one or two-unit electric heaters which come in narrow strips and can be placed directly inside the motor frame beneath the windings. Care should be exercised to avoid the generation of too great an amount of heat, a gentle heat sustained for some time being more satisfactory. If the motor has inclosing covers, they should be removed to allow the heated



General Electric Co. photo

Motors will operate satisfactorily under adverse conditions if they are kept clean internally. Free flow of air for cooling is important.

air, with its moisture, to escape readily from the top of the machine.

In new motors the air gap is *probably* correct so that the clearance between the rotor and the stator punchings is even all of the way round. However, this should be checked with an air gap gage even on entirely new machines. In any machine that has been used a check of the air gap is of decided importance since the shaft or the bearings may have become worn and may have allowed the rotor to settle to a point below the center line of the stator. A low rotor will throw the motor out of electrical balance and result in lowered power factor even when the decrease of gap is not sufficient to cause actual contact between the rotor and the stator. This change of air gap is due to wearing of the bearings and should receive immediate attention since a very slight rubbing of the rotor on the stator laminations may generate sufficient heat to destroy the coil insulation, requiring rewinding or replacement of some or all of the stator coils.

For proper operation, the bearings of all rotating apparatus must be adequately lubricated. Inspection for such lubrication may be made through the covers of the oil wells, and as soon as the motor is started a similar inspection through the covers of the wells should be made to make sure that the oil rings are functioning properly. If the motor has been stored, or brought from another job, it is advisable to drain the bearings and wash them out with kerosene before refilling with fresh oil, which should be obtained from the motor manufacturer in a grade especially suited for the motor and for the conditions under which it will be used.

Maintenance requirements

If the preliminary inspection has been thorough, and all detectable causes of trouble eliminated, the chances are very good that the motor will perform for a long time without requiring special attention. Nevertheless periodic inspections should be made on lubrication, the air gap and the bearings.

The most frequent cause of trouble with an operating motor is with the bearings, due to lack of oil. This is most easily remedied when first detected but, if neglected, may cause long shutdowns and involve considerable work and expense.

When a motor is properly lubricated its shaft bears directly on the bearing lining only when the motor is not running. As soon as revolution starts, oil is drawn under the shaft where it forms a thin film upon which the shaft runs. This explains why a machine that is continually started and stopped will be subject to greater bearing wear than one that operates for long periods in a constant direction.

Worn bearings may often be remedied at the job by rebabbitting but this takes time and involves extended shutting down of the machine. A stock of duplicate bearings is often justified so that replacement can be made immediately and rebabbitting done at leisure. Better than this is to send the worn bearings to the manufacturer for reconditioning.

In operation, as well as when idle, the need of cleanliness is imperative. Dust and dirt may so clog the ventilating openings of a motor as to shut off partially or completely the free flow of air over the windings and allow them to heat and eventually burn out.

In starting equipment on a new job it is advisable to check the load on the motor when it is in full load operation. This may be done easily by taking an ammeter reading at the motor and comparing it with the ampere rating shown on the nameplate. If the motor is properly protected an overload device on the controller operates to shut down the motor before the windings attain a dangerous temperature. If this happens with undue frequency it is an indication that the motor is overloaded and should be replaced with one of greater capacity. Do not try to remedy the condition by adjusting the overload release to make it carry increased load. Such an action will have much the same result as that of tying down the safety valve of a steam boiler.

Breakdown of insulation may be caused by failure to keep the windings free from oil. A moderate amount of moisture may dry out as soon as the motor is placed in service but oil does not evaporate. Rather, it collects and sooner or later results in insulation damage. A perfect bearing will not leak or throw oil, but many bearings are not perfect and even with oil guards, some oil may leak out of the ends of the bearings and get onto the shaft. Split bearings also may develop oil leaks at the joint between the two halves permitting the escape of oil. The shafts of any motors, between the bearings and the rotor, should therefore be carefully wiped daily to remove any such oil and, if its presence is persistent, the difficulty should be remedied by replacement of the oil guards or by the insertion of a thin layer of some absorbent paper or sheet fiber between the upper and lower halves of the bearing shell.

Machinery for use out of doors is normally in weatherproof cases but, as a further precaution, it is well to keep all motors covered with a tarpaulin when not in actual use.

Keep controllers clean

Of the equipment troubles which may arise during operation, those connected with the control apparatus are perhaps the most frequent since modern controls are all of the inclosed type and therefore not readily

observed in use. A most frequent controller trouble is due to sparking across current-breaking contacts when they are opened, giving rise to burning and pitting. It is a good plan, once in a while, to open the control casing and observe the operation. Contactors should be kept perfectly clean and may occasionally be rubbed with a bit of fine sandpaper. They should never be lubricated since oil or grease will collect dirt and dust.

An adequate supply of contact parts should be kept on hand for emergency in case of damage so that replacement may be at short notice and long shutdown of the machine obviated. For outdoor work controls are, or should be, contained in weatherproof casings which are cadmium plated and thus rendered resistant to moisture. For the same reason, many of the parts composing the control are also cadmium-plated as corrosion of such parts might result in serious trouble.

The interiors of all control casings, as well as the component parts of the controls themselves, should receive periodic wiping with a dry cloth since even a small quantity of dirt which may find its way into the casing may cause trouble by lodging upon the contact-making parts.

Storage of idle motors

First and foremost in the consideration of storage is the selection of a place which is both clean and dry, with special emphasis on the dryness. The presence of moisture in the air of any storage space will cause slow but sure corrosion or rusting of ferrous parts unless properly guarded against, while moisture will also penetrate the insulation of the windings. Since all air is liable to contain a percentage of moisture, all steel and iron parts should be thoroughly greased or slushed before being put away. For this purpose a cheap grade of grease is good or special protective compounds may be had from the manufacturers of greases and oils.

Controls should also be given a protective coating of grease on all parts which might be subject to corrosion. This includes shafts, contact parts and especially springs which are not usually made of non-corroding material.

Previous to storage, the motors should be subjected to a thorough inspection and if any undue wear is evident corrections should be made at once rather than waiting until the machine is again to be put in service, when there may be little time for proper inspection and repair. Inspection before the machine goes into service should still be made on the job to detect any damage that may have occurred during the moving of the motor.

When the preparation for storage is completed the tarpaulin covers should be placed carefully over the motors and securely tied down. A few hours spent in preparing the motors for proper storage may result in the saving of many hours when the time comes to place the machines in service again.

Washed Samples for Plasticity Tests

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***Contents in Brief**—Tests showing falsifying action of fines associated with aggregates on plasticity index lead Kansas highway engineers to a wash method of sample preparation. New test procedure described.*

SAMPLE PREPARATION for plasticity-index tests by the conventional dry method has been replaced in Kansas practice by a wash method in testing stabilization mixes. It has been found impossible by the dry method to remove all the fines or binder material from the coarse aggregate with the result that the test gives an apparent rather than a true index. At times the true index may be as many as 18 points higher than the apparent index. The wash method is a practicable method of removing disturbing associated fines from the coarse aggregate and it has been required in the Kansas state highway department specifications since April, 1939.

Recognition accidental

Variation of dry and wash method determinations was partly recognized in 1936 when the wash method was used on a single stabilization project in Greenwood County. However, proof was insufficient to warrant change from the dry method and it was continued. Accidentally in January, 1939, attention was centered on the variation by a required retest. At that time check tests were desired on a certain trial mix after the surplus of the original sample had been discarded and it was necessary to break down the already tested part for the check tests; this part in the first trial study had been compacted at about 10 per cent moisture and oven dried. The calculated index for the trial mix had been 3 but the retest gave an index of 8.

All materials and calculations were carefully rechecked, and the conclusion was finally reached that the increased plasticity could only be due to the presence of binder material associated with the primary aggregate (a glacial gravel deposit). In the original test using the dry method of preparation this fine material was absent and thus gave an apparent plasticity index that was lower than the true plasticity index.

After the cause for the variation in index figures was established and substantiated by additional research, a wash method of preparing samples was developed. This method is now used on all aggregate-binder stabilization mixes and on any material in which binder is intimately associated with an aggregate. Some of these materials in Kansas are clay, limestone, bar river gravels, glacial gravels and crushed materials, particularly those from soft limestones.

Tests now have gone far enough to indicate that the difference between the apparent and the true plasticity index may vary greatly with the character of the material so that it is not possible to use a dry method of sample preparation and from the test results predict what the true plasticity index will be. During the construction season of 1940 further study is being conducted from which it is expected final conclusions may be drawn. The tentative conclusions now possible are given at the end of this article.

A definite procedure is followed in

the Kansas highway department soils laboratory in working up a stabilization report for the preparation of specifications for any stabilization operation. Routine laboratory tests to determine gradation and plasticity index are run on all samples of material from the locality of the project which are to be considered for possible use in stabilization. The gradings and plasticity indices for various combinations of these materials are calculated. Then from the calculated mixes three combinations are usually selected and an actual trial mix of each is made up in the laboratory. This trial batch is of sufficient size to provide a portion for compaction in a special 1/10-cu. ft. mold and also a separate portion for gradation and plasticity index tests. The gradation and plasticity index tests are run on each trial mix as a check against the calculated mix.

Each trial mix is compacted in the 1/10-cu. ft. mold at several different moisture contests to establish the approximate optimum moisture and weight per cubic foot to be expected from each combination, and to give a basis for comparison between the several possible combinations. The special 1/10 cu. ft. mold was adopted to provide sufficient capacity for compaction of the total mix rather than that portion of the material passing a No. 4 sieve. The mold is a cylinder about 6 in. in diameter and 6 in. high, and is similar in design to the regulation 1/30-cu. ft. Proctor mold. The material is compacted into the cylinder in four lifts instead of the usual three, and additional blows per lift are used so as to cover the greater cross-sectional area adequately.

As stated the wash method is used for preparing samples for the plasticity index tests. This method is precisely specified and in general is as follows: A sample is obtained by splitting or quartering and of a size sufficient to provide at least 300 grams of dry material passing the No. 40 sieve, and this sample is dried to constant weight. The sample is then dry screened over a No. 40 sieve to remove as much of the material passing the No. 40 sieve as possible. Several larger screens are used in this process to keep part of the load off the No. 40 sieve. The material passing the No. 40 sieve is set aside for later recombination with additional material obtained in following steps.

After dry screening, the material retained on the No. 40 sieve is washed over a series of sieves ending with the No. 40, *saving all of the wash-water and material.* As the material on each sieve becomes clean, it may be removed to a pan for drying. With some types of materials, such as clay-gravels, it may be necessary, before washing, to place the sample in a pan, cover it with water and permit it to soak in order to break down particle aggregations. The entire sample is then evaporated to dryness, *taking special precaution to prevent burning the fine materials.* In most cases after a short period of heating, the soil particles in suspension will settle out so that the clear water at the top of the pan may be siphoned off to reduce the drying time.

Any material which was washed through the No. 40 sieve, which caked during the drying process, is again broken down to pass the No. 40 sieve by rubbing with a rubber-covered block. This rubbing is done, in so far as possible, in a manner which will not change the characteristics of the material. The dried material retained on the No. 40 sieve during the washing process is dry screened over a No. 40 sieve after which the material retained on the No. 40 sieve may be discarded.

The material passing the No. 40 sieve obtained by the initial screening, that obtained by washing and that obtained by rescreening the coarse material after washing, are all recombined and thoroughly mixed. The lower liquid limit, lower plastic limit and plasticity index tests on the prepared sample are then conducted according to the standard methods of the American Association of State Highway Officials.

What is concluded so far

From the test results and experience so far obtained the conclusions seem warranted that:

1. The usual methods of preparing samples for plasticity index test for ordinary soils cannot be used for aggregate-binder stabilization materials and stabilization mixes.

2. Some method of washing the binder from the aggregate must be used if the prepared sample is to give the *true* plasticity index of the material.

3. The *apparent* plasticity index for an aggregate-binder stabilization material or mix as determined on a sample prepared by the conventional method of dry rubbing and screening may vary from the *true* plasticity index of the same material, as determined on a sample prepared by the wash method, up to 18 points or more, depending upon the character of the material.

4. Since the variation between the results obtained on samples prepared by the two methods is not constant, it is impossible to apply a correction to the *apparent* plasticity index in order to arrive at the *true* plasticity index.

5. The use of the dry method of sample preparation for control of aggregate-binder stabilization construction may, in some cases, result in a finished roadway with an *apparent* plasticity index well within the specification limits, but which actually has a *true* plasticity index much too high to be acceptable.

Mosquitoes in London's Underground Shelters

An unexpected trouble in the use of the London "tube" railways as shelters from bombing raids is the appearance of mosquitoes. From press reports quoting *The Lancet,* leading medical journal, it seems that many people sleeping in the underground stations have been bitten, and that this was first attributed to some stray insects prior to their hibernating. Investigation revealed that breeding was in progress as late as November. Breeding places were found in such places as between the tracks and under the platforms, where pools of stagnant water remained. Temperature appeared to be a critical factor in hibernation, and the number of insects was dependent upon the extent of suitable breeding grounds.

Under the present exceptional conditions, the temperature is about 70 deg. F., the occupants of the stations provide an ample supply of blood, and there is an absence of all natural enemies, so that breeding is continuous throughout the year. It is reported that the London Passenger Transport Board is taking steps to exterminate the pests, probably by spraying creosote or paraffin. As to the species, only the *Culex Molestus* appears to be mentioned, so that discomfort, rather than disease infection, is the main result of the infestation.

Corrugated Iron Inclosures Reduce Cost of Biofilter Units

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USE OF corrugated iron sheets instead of reinforced concrete for biofilter inclosures at two plants in California resulted in a saving of about 20 percent in the cost of the walls of these structures. This normal departure from conventional practice in sewage treatment plant construction is based on successful experience previously with small 15-ft. tanks made of the same material. The corrugated iron inclosures, properly painted, have resisted the corrosive action of sewage and the deteriorating effects of fog and salt water exposure in the San Francisco area.

The economics of construction using corrugated iron at plants for Lakeport and Ceres, Calif., is shown in the table. The manner in which the sheets are fabricated to form the inclosure is shown in the accompanying illustration of a 36-ft. biofilter at the Lakeport plant.

Undoubtedly there is a limitation to the use of corrugated iron sheets, depending on the diameter of the bed. Experience seems to indicate that 50 or 60 ft. would be the limiting diameter. Beyond that value, the curvature of the inclosure would become so flat as to necessitate, in all probability, some means of stiffening the corrugated sheets against bulging; naturally this would increase the expense of construction. Also, on large diameters, the inclosure would have the appearance of a thin ring and from the standpoint of appearance would not be as satisfactory as a concrete wall of substantial thickness. In general, however, the corrugated iron inclosures would be well suited to medium-sized and small plants, such as those for institutions, towns and camps.

Cost Data on Corrugated Iron Inclosures for Biofilters

	Lakeport Plant	Ceres Plant
No. of beds	2	1
Dia. of beds	36 ft.	45 ft.
Total Cost*		
Reinforced concrete	$800	$480
Corrugated iron	$650	$375
Approx. saving	19%	22%

*Includes painting: Concrete, 2 coats cement paint outside; corrugated iron, one coat asphalt inside and two coats aluminum outside.

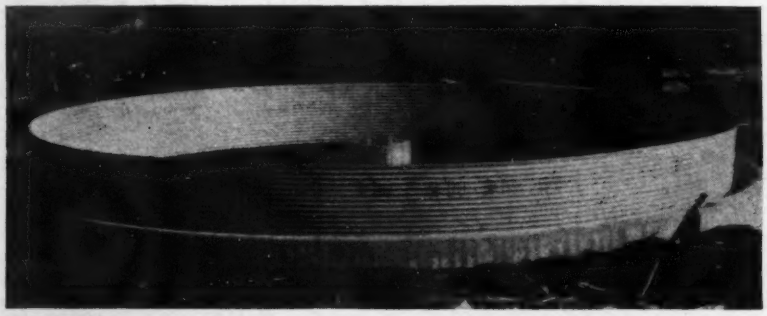


Fig. 1. Biofilter inclosure with corrugated sheet iron walls at the Lakeport, Calif., sewage treatment works.

Fig. 2. A small disposal plant at San Leandro, Calif., where three 15-ft.-dia. corrugated iron biofilters are in use.

The possibility of using corrugated iron inclosures at a saving in cost of from 20 to 30 percent over concrete is a direct result of the shallow 3-ft. rock beds employed in the design of the biofilter, and it is doubtful that corrugated iron sheets would be structurally satisfactory for the trickling filter of conventional depth.

Experience under California conditions reveals that the useful life of the paint job appears to be about three years, for either the corrugated iron or the cement paint on concrete. The aluminum paint used on the outside of the corrugated iron structure is readily applied by spray gun at small cost.

Sewage Treatment and Infantile Paralysis

That much of the responsibility for preventing poliomyelitis, or infantile paralysis, may be placed on those who have charge of preventing sewage pollution of streams, is stated by the Illinois State Department of Public Health in its bulletin *The Digester*. As explained, the isolation of the polio virus from human feces has been followed by the isolation of this virus from the raw sewage of a city experiencing a polio epidemic. It is known "that the virus can gain entrance into the central nervous system through the olfactory nerve endings; that this avenue of infection is quite common, that in many polio epidemics the points of highest incidence seem to be in communities bordering on sewage-polluted waters used for bathing; that in some epidemics more than 25 per cent of the cases showed a history of bathing in contaminated water, and that epidemic poliomyelitis occurs invariably during the late summer months. This seems to challenge the generally accepted theories of the epidemiology of this disease and raises the reasonable possibility of infection by swimming or bathing in sewage-polluted waters. The significance of this is apparent to every sewage treatment plant operator."

A Thousand Buildings in Five Months

***Contents in Brief**—Completing plans and organizing a force of 13,500 men all in a few weeks, builders of the Indiantown Gap, Pa., army camp are about to complete the $14,000,000 job. After three months the first troops were moving in; after five months the essential housing was 100 percent complete; and at the end of six months the entire project will be completed. Work includes construction of 1,054 buildings, 25 miles of new roads, a sewage treatment plant, 22 miles of sewers, 25 miles of water mains, a 500,000-gal. steel water tank, 34 miles of power distribution lines, and about 300,000 cu.yd. of grading.*

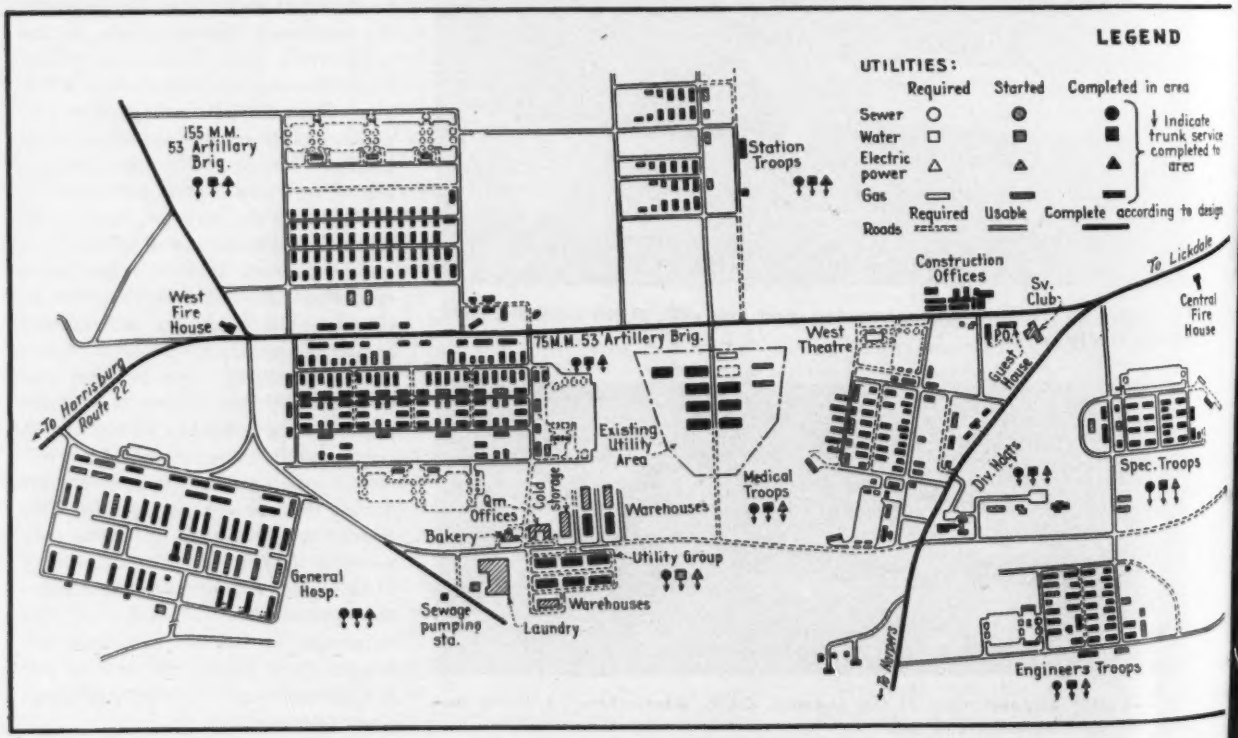
REQUIRING CONSTRUCTION of 1,054 buildings and costing $14,000,000, the Indiantown Gap camp is being built by the War Department 20 miles east of Harrisburg, Pa., to house 25,000 troops. Although the architect-engineer's contract was let Sept. 19, 1940, and the construction contract Sept. 25, with ground broken Oct. 9, the entire project was 84.8 percent completed on March 8 and the essential housing 100 percent. Some of the buildings were already housing troops early in January, and all the work is scheduled for completion April 15.

To use a peak force of 13,500 men for making 40,000,000 b.ft. of lumber, 43 carloads of millwork, 42,000 squares of roofing paper, and 40,000 cu.yd. of concrete into living quarters has required unusual emphasis on organizing and handling labor. The work has also demanded the greatest cooperation on the part of the Army's, the engineer's and contractor's men.

Winter weather, nearness of the water table to the surface, the underlying shale, and the need to make use of buildings previously constructed for summer training of the Pennsylvania National Guard have not made the job an easy one. Originally the program was estimated to cost $6,211,765. However, since then the total number of buildings has been increased from 788 to 1,051.

Construction now includes 346 two-story 63-man barracks of the standard design described in *ENR*, Oct. 24, 1940, p. 537, 135 mess halls of frame one-story construction, 56 frame one-story hospital buildings providing room for 1,000 beds, 24 frame one-story warehouses, 42 officers' quarters, 17 headquarters buildings, and 434 miscellaneous structures. The latter include two theaters, eleven recreation halls, a guest house, a service club, a bakery, a large laundry and 900-hp. boiler plant for the hospital. Location of the individual structures on the hilly 3,500-acre site and the status of work as of March 8, including roads, water mains, power lines and sewer facilities, is shown by the accompanying map. How the project lends itself

Location of all roads, reservoirs, the sewage disposal plant, and the many different buildings of the Indiantown Gap army camp are shown by this drawing and that at the right. March 8 status of the various phases of project is also given.



to division into nine construction areas, each directed by a superintendent, is also shown in the map.

Dimension lumber for the project is delivered to a common sawmill yard. Here it is classified and cut to the required length and shape by eight table saws for delivery to particular locations as needed. One-inch material, such as siding, flooring, and sheathing, goes directly to the area where needed, only the surplus going to the common store yard. Millwork, except doors, comes to the job unassembled and after assembly is delivered for each building as required. Gypsum board goes directly to the separate area, while the nails, the building and roofing papers, and plumbing and electrical equipment are received at a common storage yard. A batching plant supplies all concrete as transit mix at the point where needed. Lumber needed early in the construction program often arrived long after lumber not required until later, causing considerable delay and rehandling when the work was first begun. There has been little trouble with other materials.

Construction of frame buildings

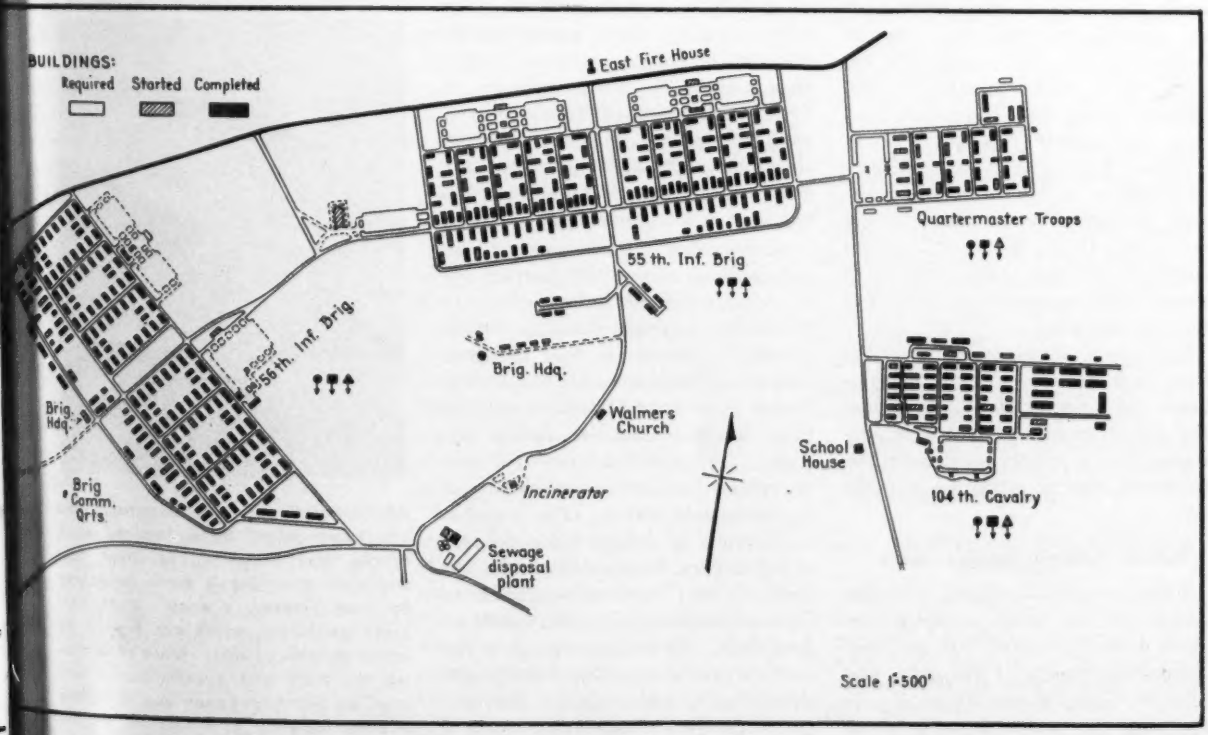
In construction of the various frame buildings special crews do special jobs, that is, one group does the foundation excavation and then passes to the next building, to be followed by a crew for putting in the foundations, a crew for the sills, a gang for the rafters, a siding crew, and a roofing gang. At the peak of construction there was a total of 13,500 men employed. This included about 200 War Department workers, an equal number with the engineer, and over 13,000 men on the contractors' payrolls. Labor comes from as far as 70 miles away but there has been no shortage. Part of the time two shifts were used. This, together with night work and other overtime, particularly on the water supply and sewer systems, has caused an increase in the cost.

A small part of the Indiantown Gap cantonment in Pennsylvania for housing the 28th Division of the Pennsylvania National Guard and the 104th Cavalry.

Hourly wage rate are $0.50 for common laborers, $1.00 for carpenters, and $1.25 for electricians, plumbers, and similar skilled workers. A large majority of the laborers are non-union, but about 80 percent of the carpenters and a larger percent of the other trades are union workers. Although there have been several minor controversies with the union officials, there have been no strikes. Because of the speed required on the work and the necessity of assembling so many workmen in such a short time, the efficiency of the labor has been low.

Roads total 25 miles

Although the road work is being carried out at the same time as the



One of the 346 standard 63-man frame barracks required. Enclosure is ¾-in. dressed inner sheathing, building paper, and drop yellow pine siding. Floors are of straight-grain fir on ¾-in. underfloor with building paper between. The building is built on reinforced concrete posts, is heated by an individual automatic anthracite coal heater, and has showers and toilets.

building construction, it is not complicating the later program nor has unusual trouble been experienced because of mud. The general scheme has been to build first the roads requiring little grading. Once the grading was complete the road was surfaced with broken shale obtained nearby to make a serviceable road for construction purposes. As the entire program nears completion the roads are being surfaced with crushed stone and screenings and later a blacktop surfacing will be applied. A total of 25 miles of new construction is necessary, but the road problem was simplified by the fact that U. S. Route 22 passes lengthwise of the camp. Extensive access road construction therefore was not necessary.

For power distribution, the contractor's forces are building approximately 34 miles of electric transmission and service lines. Power is purchased from a private utility with the maximum demand estimated at 3,500 kw.

Private concern supplies water

Water supply facilities are designed for an average daily per capita consumption of 100 gal. and a peak requirement of 250 gal. The Lebanon Consolidated Water Co. is supplying the water from a plant three and one-half miles away on Swatara Creek near Jonestown. To supply water for the Pennsylvania National Guard during summer training at the camp site a 10-in. cast iron line from the plant to the camp had been built some years ago. The added consumption of the greatly enlarged camp calls for construction of a new 12-in. supply line approximately three miles long of asbestos cement pipe. Also, the water company is doubling the size of its old 3-mgd. purification plant, and providing prechlorination treatment with lime and alum, filtration with rapid sand filters, and final chlorination.

At the camp, 22 miles of cast iron distribution mains, 55 percent of 6-in. dia. and the balance 8-in. to 12-in. dia., is being installed. Ditchers and backhoes are used for excavation and bulldozers for backfilling. Water is to be delivered at not less than 30-psi. pressure during fire flows. About 240 new fire hydrants are being installed with spacing of approximately 400 ft. The distribution system is designed for delivery of 1,000 gpm. from any two adjacent hydrants and is cross-connected to form a complete grid system with no dead ends. At present storage at the camp is provided by one 500,000-gal. elevated tank and a similar 250,000-gal. structure. Under construction is a 500,000-gal. elevated steel tank. Together the three elevated tanks will make possible storage for about a 12-hr. demand.

Sewer mains total 22 miles

To provide sewerage facilities, 22 miles of tile sewer lines are being constructed by the same general procedure as the water mains. Considerable blasting is required because of the nearness of the shale to the surface. The sanitary sewers vary in size from 8-in. to 12-in. dia., with the greater part of 8-in.

The job of doubling the size of the existing Imhoff tanks to make the total normal capacity 1.8 mgd is about complete. Just started is the construction of two trickling filters. For sludge drying, 18,900 sq. ft. of beds designed to provide ¾ sq. ft. per capita is planned. Most sewage flows to the plant by gravity. However, for the hospital area a pumping plant equipped with two 500-gpm. electric and one 500-gpm. gas-engine-driven pump operating against a 65-ft. head has been constructed. The existing intercepter and outfall sewers are being utilized.

For the disposal of garbage an incinerator is being built. This structure is located just east of the sewage disposal plant, and has a capacity of 10 tons per 8 hours.

All 56 buildings of the hospital group are being joined by a covered walk of the type shown above. High construction in center is made necessary by walk crossing a road. Note concrete pedestals, which are topped by metal termite shields. Work of enclosing the walk with gypsum board covered by building paper and sheathing is under way.

Barracks, recreation and administrative buildings and officers' quarters and warehouses are heated by hot air from individual anthracite coal furnaces. For the 56 frame buildings of the hospital unit a steam plant is being built, which will include a 400-hp. and a 500-hp. boiler unit, equipped with chain-grate stokers for burning buckwheat coal. It is of steel-frame construction with the walls and roof of sheet metal.

The hospital buildings also differ from the barracks units in that they are all of one-story construction and, to provide for easy transportation of wheel-chair patients from one building to another, are interconnected by covered and enclosed walks. These walks are of frame construction and are enclosed with gypsum board covered by building paper and siding. The roofs are of bituminous roll roofing. The wooden roof trusses of these walks carry the steam mains for the hospital units.

Single laundry planned

Under construction is a 300 x 218-ft. frame one-story central laundry. This structure will be equipped with $300,000 worth of mechanical equipment, and is to have its own heating plant.

Gannett, Eastman & Fleming, Inc., Harrisburg, Pa., the architect-engineer, is represented on the job by W. H. Corddry, vice president, with D. R. Cooper, as principal assistant engineer. The general contract is held jointly by W. F. Trimble & Sons Co., Pittsburgh; Ferguson & Edmondson Co., Pittsburgh; and The Huffman-Wolfe Co., Columbus, Ohio. They are represented on the job by C. R. Carter, general manager, and James Marshall, general superintendent. Maj. W. L. Kay is constructing quartermaster for the War Department. The work is being done on a cost-plus-fixed-fee basis.

A Building Every 54 Min. at Fort Ord

***Contents in Brief**—Success in putting up buildings at Fort Ord, Calif., at the rate of one for every 54 minutes of working time in a 3½-month period is ascribed to (1) a lump-sum contract with attendant freedom for the contractors' organization and methods, (2) a building erection scheme that eliminates the need for staging around barracks, (3) well-organized construction crews with specialized assignments and (4) maximum precutting of lumber and prefabricating of units to minimize assembly operations.*

HOUSING FACILITIES for men mobilized under the draft have been provided ahead of contract schedule at Fort Ord, Calif., where provision for 25,000 officers and men is being made under a lump-sum contract. Terms of the first contract called for completion of one building for every hour of actual working time during a 3½-month period. This requirement was more than met as the average was only 54 minutes on the first 820 buildings put up. The total number of buildings is about 1,200. Some of the factors that contributed to high speed are outlined in the following:

The contractor laid out the work at the outset in several "divisions" each under a superintendent whose attention could be given wholly to one area. An "expediter" assigned to each superintendent serves as liaison officer to see that every item of equipment, materials and supplies arrives in his division just where it is needed and in time to avoid delaying scheduled operations. This includes precut lumber and prefabricated parts, which constitute as high a percentage as possible of the total of materials used.

All lumber (totaling some 35,000,000 b.ft.) comes to the job surfaced on all four sides. No planers are needed but saws are much in evidence. Eleven bench-type, circular saws are mounted near the railroad siding and 140 portable, power-driven saws are used on the job. Very little sawing is done by hand power.

By use of a construction plan in which the walls, one story at a time, are put together on the flat and then erected to vertical position, the need of staging on the outside of the buildings is almost entirely eliminated. The only falsework used is a low working platform, at the level of the first-story windowsills, from which brackets under the so-called "eye-brow" roof projection over the lower floor are nailed to the wall after the second-story walls are erected. These "eye-brow" roofs are put together as part of the second-story wall panels, their brackets swinging out exactly into place ready for nailing to the walls when the upper story wall goes up.

Each crew is trained for its specialty and moves from building to building as the specialty operation is completed. Thus the 2,700 men that represented peak employment were organized in crews of usually not more than 20, a superintendent coordinating the operation of each group of crews. The several superintendents (sometimes there were as many as 10 or 12 divisions) clear through the general superintendent. In short, the job as a whole has been organized as a large number of smaller jobs with separate control in each part and with details minimized by precutting and prefabrication.

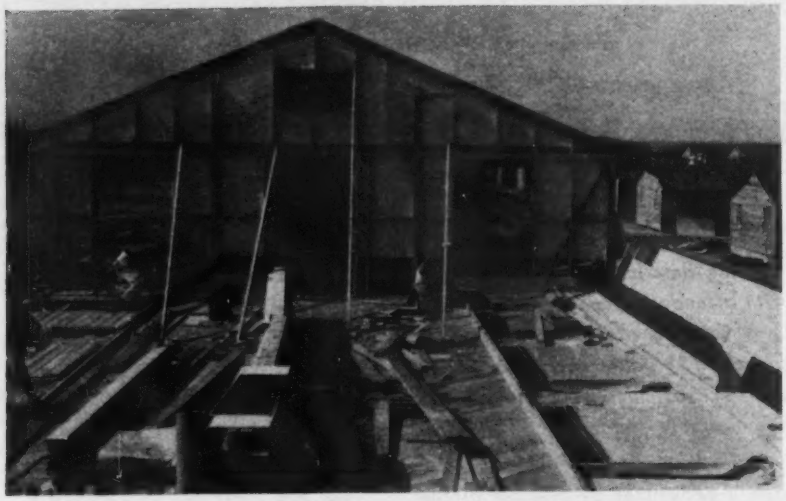
At the height of the work, the maximum number of contractors' employees in engineering and supervisory capacities, including all checking, bookkeeping, ordering, etc., was only about 70 employees. This is believed to be much fewer than could have handled the work on a fixed-fee basis with the additional inspections, checking, reports and records that would have been required.

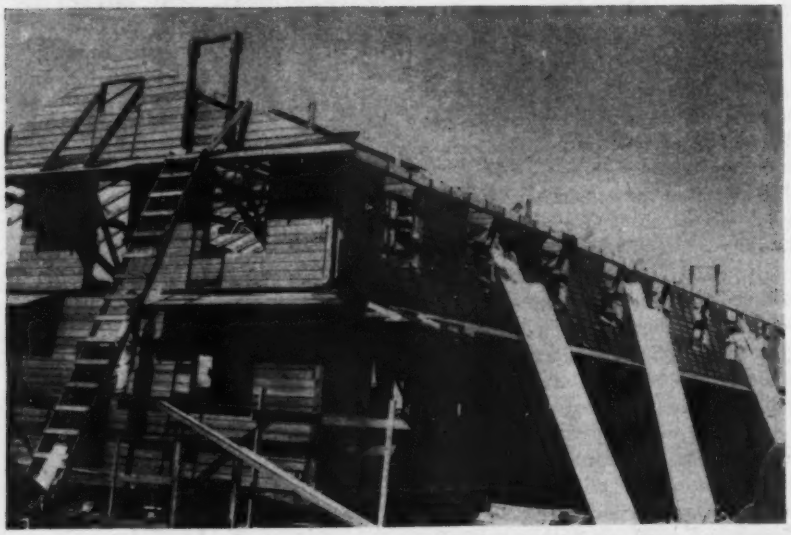
Essential data on the construction program at Fort Ord are outlined in the following summary.

DATA ON FORT ORD CONSTRUCTION PROGRAM

Location and Size—Fort Ord is near the shore of Monterey Bay, Calif., 6 miles northeast of Monterey, Calif. Total area, 19,000 acres. Most of the buildings are concentrated in the main garrison occupying an area about 7,000 ft. square.

Of the total of 1,200 buildings provided





For the standard 63-man barrack (top), the walls are laid out and completely assembled on the sub-floor before being swung up to vertical position, thus eliminating need for staging. In laying out second-story wall sections (center), "eye-brow" roof projections that shelter the lower floor are attached while the wall is flat. At the right, building paper covers gypsum sheathing. At the left, 1-in. t&g boards are being put on over the building paper. The low staging (bottom) around this standard barrack is used for nailing brackets that move up into place with the "eye-brow" roof projection. No other staging is required. Roof sheathing is stacked ready to be handed up. Note absence of waste around the building.

for in contracts let up to Feb. 20, this year, 398 are the standard 63-man barracks. In addition to the usual buildings (including one 25x48-ft. recreation hall) in each company street, the cantonment includes numerous special buildings such as warehouses; four theaters each seat 1,038.

Contracts and Requirements—Three major contracts, all on the lump-sum basis, have been awarded to the Ford J. Twaits and Morrison-Knudsen Co., Inc., Los Angeles. These contracts and the amount of lumber involved in each are as follows:

Awarded, Aug. 28, 1940, completion date Nov. 30, 1940.....14,000,000 b.ft.
Awarded Nov. 2, 1940, completion date Jan. 3, 1941.....16,000,000 b.ft.
Awarded Jan. 7, 1941, completion date Apr. 3, 1941.....5,000,000 b.ft.

The first of these contracts was for $2,730,000; the total for all three is about $9,000,000.

Major Features—Included in the cantonment is a hospital unit of 101 buildings (1,500 beds). In addition to the large quantity of lumber which is the major item in the bill of materials there are 3,000,000 sq. ft. of gypsum sheathing; 4,000,000 sq. ft. of insulating board for interior partitions and 6,000,000 sq. ft. of building paper.

The water supply is obtained by pumping from wells to eight 120,000-gal. wood-stave tanks. Gas and electricity are purchased from private utility companies. Initial grading included 2,000,000 cu. yd. and there is some 300,000 sq. yd. of paving (5-in. compacted rock base and 2½-in. asphalt- impregnated surfacing). Sewage disposal by modified Imhoff plant with effluent discharging to ocean.

Personnel—Col. H. S. Stetson is constructing quartermaster and Capt. A. H. Griffin is engineer officer. The general contract is held by Ford J. Twaits and Morrison-Knudsen Co., Inc.; R. M. Conner, project manager and Paul B. Tichenor, general superintendent.

City Planning Promotes Denver's Development

The difficulties, and also the possibilities, of applying city-planning and zoning principles to the improvement and development of a city whose early growth has been under the usual haphazard and unregulated conditions, are exemplified in the 60-page "Denver Planning Primer", as revised for 1940 and issued by the Denver Planning Commission. Denver, Colo., was founded in 1858 as a mining settlement and its population increased from 4,749 in 1860 to 106,713 in 1890. Its growth is treated in a general chronological manner. Opening with a statement of the city's early history and its growth through 82 years, the pamphlet shows what planning has accomplished in eliminating undesirable features and effecting important public improvements on a large scale.

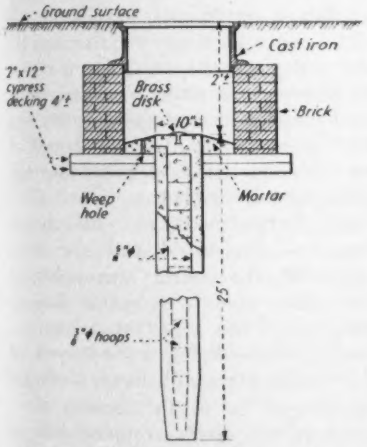
From Field and Office

Working problems and time-saving methods for engineers and contractors

Reinforced Concrete Piles For New Orleans Benchmarks

Because many benchmarks in the city of New Orleans have been affected by the lowering of the water table, several groups of square 25-ft.-long reinforced concrete piles surmounted with standard manhole frames and covers, as illustrated in the accompanying sketch, have been established as benchmarks through the cooperation of the U. S. Engineers and the New Orleans Sewerage and Water Board. The manhole is of brick masonry surmounted by a 24-in. cast-iron frame and cover which bears the letters "B.M." The frame is designed to prevent the heaving or separation of both the foundation material and pavement from the frame. This feature is a recessed section around the circumference of the frame into which the foundation material can be packed.

Because properly inscribed bronze disks serving as the benchmarks were to be cemented into the recessed heads of the piles, a special wooden cap was used for driving the piles to prevent shattering.—EUGENE N. BOWLING, *associate engineer, U. S. Engineers Office, Jamaica District, Kingston, Jamaica.*



Reinforced concrete piles 25 ft. long and protected in manholes are used for New Orleans benchmarks.

Delivery Boxes on Legs Aid in Concrete Cleanup

Delivery of reinforcing steel, pipes, fittings, small tools and materials such as wooden wedges, small lumber orders, etc., on Friant Dam has been expedited by the use of wooden delivery boxes. These boxes are loaded at the warehouse, carpenter shop or some other point where materials or parts are stored or made, are there placed on flat cars and from the service trestle are delivered by the derrick to destination written on a tag attached to each box.

The legs at the four corners, usually made up of steel angles of convenient size available when the boxes were put together in the shop, are long enough to elevate the bottom of the box about 2 ft. above the concrete surface. This allows space for sandblasting or washing off beneath the box without necessitating a move. The boxes themselves are substantially built of 2-in. plank and each is equipped with a sling for convenience in handling.

In addition to small, square boxes like the one shown in the picture, a larger size of the same width but two or three times as long is popular with pipe-fitting crews because fittings, tools and materials can be stored conveniently in any block and quickly moved to the next scene of operations as the work advances.

Protection When Blasting

To reduce damage due to flying missiles when blasting, a salvaged woven steel fencing was recently used to advantage on a Milwaukee job. The fencing, 8 ft. wide, was cut into 30-ft. lengths with an oxyacetylene torch. Heavy green saplings were then "sewed on" at 6-ft. intervals to act as stiffeners, No. 6 car stake wire making an ideal wire for this work.

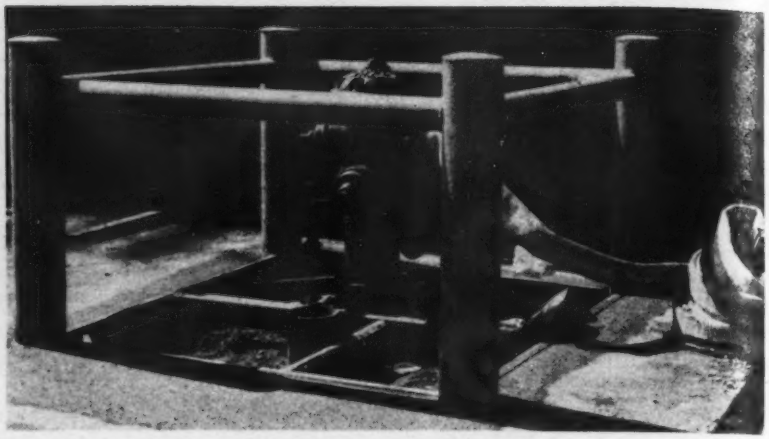
Later, when a ready supply of green saplings was no longer available, 3x3-in. or about that size scrap angle iron was substituted for the poles. The angle irons proved many

Scrap fencing and angle irons used for reducing damage due to flying missiles when blasting.

Elevated boxes of this sort are handy in cleanup after finishing a pour (smaller size) and for storage of parts and materials. As here shown, a skip and other gear can be stored on these boxes temporarily to be clear of sluicing operations.

times more durable and they could be straightened by heating and hammering.

To act as an insulation in preventing damage to the network of connected electric detonators and to prevent possible current leakage, it is advisable to first provide a checkerboard pattern of scrap timber or poles. Also, it is suggested that a series or series-parallel circuit be employed to enable the blaster to check the circuit for continuity, "shorts," and leaks once the work of placing the mats is complete. — PAUL C. ZIEMKE, *Milwaukee, Wis.*



Welded pipe enclosure protects hydrant from damage by motor trucks.

Fire Hydrant Protection

A fire hydrant at the Boeing Aircraft plant in Seattle, in a yard area used extensively by motor trucks and trailers, is protected against collision damage by a framework of welded pipe. The four uprights which are at the corners of a 6-ft. square are 6-in. pipe to which a horizontal rail of 3-in. pipe is welded about 3 ft. above the pavement. This height allows space for the fire hose to pass under the rail without restriction. The posts are filled with and imbedded in concrete to a depth of about 2½ ft. below the pavement surface. The scheme was devised by the Austin Co., engineers and builders.

Cement Transfer Box

A DUST-TIGHT BOX, job-made, designed to hold 20 barrels of bulk cement, is used by the Benj. Foster Co. at Indian Rock Dam near York, Pa., for hauling bulk cement from a nearby rail siding to the concrete plant at the dam. The box is designed to just slip into the body of a 3-ton dump truck. At the concrete plant, rate of discharge is controlled by the sliding gate and hoisting of the dump body.

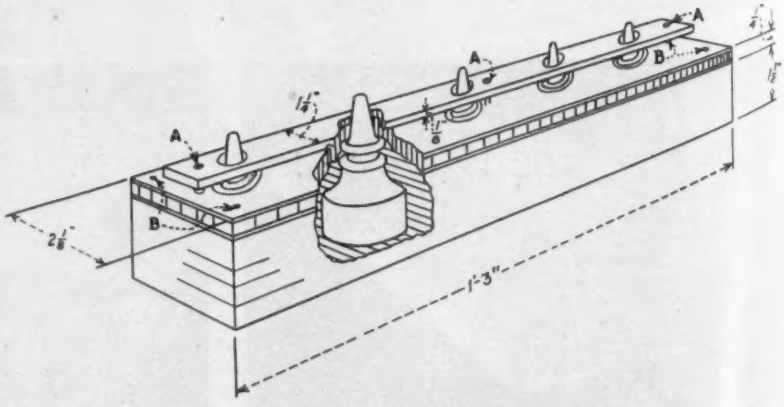
Portable Non-Spilling Ink Block

To make field corrections and additions instead of waiting for new prints to come out to the job from the city design department I have found it convenient to carry an assortment of colored waterproof inks around with me. Until having one of the containers come open and spoil my coat, I carried the bottles on the shelf back of the seat of my coupé. I now carry them in the portable non-spilling ink block shown in the accompanying sketch.

The bottom block is of white maple of the dimensions shown. In this bottom are bored five holes to fit the bottom of the bottles, which are held in place by a ¼-in. sheet of plywood drilled with matching holes and fastened with the four wood screws marked "B". For traveling, an additional strip is drawn down to cover the cork handle taps by the three screws marked "A". This prevents the corks from becoming loose and the ink from spilling.—K. N. BANTHIN, *Mining and Construction Engineer, Oak Park, Ill.*

Cement for Pipe Leaks

A modified glycerine-litharge cement that is waterproof, resistant to fairly high temperatures and that sets under water may be used to repair leaks in pipes, according to the Glycerine Producers' Association. To prepare this compound for use, equal parts of cement and litharge are thoroughly mixed together and then a volume of glycerine equal to half the volume of the mixed powders is added and the whole thoroughly mixed with a spatula or similar flat-blade tool. When repairing a leaky pipe, the hole is filled with the cement and bound in place with cheese cloth, then a quantity of the cement is daubed on the cloth wrapping and the whole is tightly bound with iron wire.



Non-spillable ink-bottle holder for use on field trips.

Book Notes and Reviews

The month's addition to the engineer's reading and reference list

Tunnel Driving Methods

PRACTICAL TUNNEL DRIVING—By H. W. Richardson and R. S. Mayo. 436 pp. Published by McGraw-Hill Book Co., New York and London. Price, $5.

The title of this book very well describes its contents. The authors have made a successful attempt to describe briefly and clearly up-to-date methods as applied to all kinds of tunnels in both rock and soft ground, including soft-ground tunnels driven by the use of shields and compressed air, timbering and placing of permanent lining and shaft sinking. Considerable space is devoted to tunnel and shaft surveys.

The book is very comprehensive with respect to modern tunnels built in this country; nothing is said about foreign tunnels. The book should be in the hands of all tunnel engineers as a source of ideas. Some of the detail descriptions are excellent. Of course the various conditions met with in tunnel construction are almost infinite, and as no two tunnels are alike as to conditions or methods followed, the authors, naturally, do not completely cover the ground.

There is a tendency to generalize too much as to methods and what the authors call standard practice based on their own investigations, which may be irritating to readers who do not agree with them and who would be disposed to argue. After all, perhaps this may be a good feature.

Considerable attention is given to the subject of ventilation of tunnels, the great quantities of air now required and the efficiency shown in putting the air where it is needed. Improved ventilation and also perfection of all the tools and materials used have much to do with the excellent results noted in recent years.

There is little on the history of tunnels and the story of the Haskins Tunnels, the first tunnels under the Hudson, as given, may be misunderstood. The authors give the dimensions as 24x26 ft. These were brick-lined tunnels, 17 ft. in height by 15 ft. inside dimensions. One could infer from the account that these tunnels lay idle from the time they were abandoned by Haskins in 1882 until taken up again by McAdoo about 1901. During part of this interval, however, an attempt was made to complete the North tunnel by the use of a shield, compressed air and cast-iron rings very much like a modern tunnel.

The statement is made that the Queens-Midtown Tunnel penetrated the worst ground through which a large shield had even been driven. This statement should probably be qualified, as the Pennsylvania East River tunnels and the original Hudson River Tunnel referred to above are competitors for this honor. It is true that at one point the Queens-Midtown Tunnel had a hard time, but in general the work was rather easy due to efficient management and an excellent clay blanket on the river bed above.—*Reviewed by* R. H. KEAYS, New York.

Land and Man

LAND ECONOMICS—By Richard T. Ely and George F. Wehrwein. 512 pp. Published by The Macmillan Co., New York. Price $4.

Engineers with a one-track mind should pass up this book. But those who have come to recognize the interrelationship of social, economic and political forces with engineering accomplishments will enjoy and profit from a reading of "Land Economics"—despite its awe-inspiring title. This book brings together an extraordinary amount of information on land utilization, most of which is directly concerned with or has influenced the activities of engineers. Furthermore, this is no academic discussion of principles but a compendium of practical exhibits, each of which gives a dramatic punch to the argument presented. Here are just two excerpts which indicate the manner in which some current issues are highlighted:

Highways: Highways are the unifying bands which tie all land uses together. They are built at enormous expense to the taxpayers, and insofar as the adjoining landowners profit, the owners enjoy an economic advantage donated gratis by the public. Therefore, the public has the right to regulate the benefited land, to protect its investment from intrusion and types of business which endanger safety and health or affect the amenities of the countryside.

Premature Subdivision: The tragedy of premature and unsuccessful subdivision lies not only in the loss of private investment but also in the fact that good farm land is taken out of use and submitted to idleness after public improvements have been made, many of them at public expense.

The authors state that the content of their book is the outgrowth of 20 years' experience in presentation and teaching. The result is worth reading.

Sewer Rental Practice

SEWER RENTALS—Bulletin No. 7 (revised 1941). Published by the American Public Works Association. 1313 E. 60th St., Chicago, Ill. Price, $1.50.

Service charge financing of public works will get much attention when the defense boom slows down. Sewerage works, in particular, lend themselves to such methods of financing. This focuses attention on the authoritative analysis of sewer rental practice made by the American Public Works Association in 1939. Now available in a revised form, which includes administrative practices and experiences of more than 100 cities, this study should make a special appeal to municipal administrators.

For those who have the earlier edition the new supplementary data is available in a mimeographed bulletin costing 15c.

Fire Protection

HANDBOOK OF FIRE PROTECTION—Ninth edition of the Crosby-Fiske-Forster Handbook. 1308 pp. Published by the National Fire Protection Association, Boston. Price $4.50.

Revised after a lapse of five years since the eighth edition came out, this new edition of the official handbook of the National Fire Protection Association contains a wealth of information of value to engineers in many branches of civil engineering. For example, engineers engaged in the design of water supply systems will find a record of the actual drafts on water supply systems made by recent large fires that far exceeded the figures given in the grading schedule of the National Board of Fire Under-

writers. Other new information includes summaries of modern building code requirements and data on newer developments in building work such as the fire prevention measures to be taken in connection with the installation of air-conditioning ducts and acoustical materials.

Ship Construction

STRUCTURAL DESIGN OF WARSHIPS —By William Hovgaard. Second Edition. 410 pp. Published by the United States Naval Institute, Annapolis, Md. Price $6.

The current increase in the construction of war vessels has resulted in a new and greatly revised edition of this book, which was published originally in London in 1915. Developments in structural design and methods in the 25 years since the first World War as well as changes in methods of making war are recognized in the new text. The chapter on riveted connections has been reduced and a new chapter on welded construction has been added. Protection against air attack has been added to the section on deck plating.

Written primarily as a text for students of naval construction, this text should be helpful to men unfamiliar with ship construction who are going into that type of work because of the current great additions to the nation's shipyards.

Miscellaneous Notes on Booklets and Reprints

A HISTORY OF THE ST. LAWRENCE PROJECT has just been published by the U. S. Department of Commerce as Part I, The St. Lawrence Survey. Six other parts are to be published soon. This one can be obtained from the Superintendent of Documents, Washington, for 10c. Judging by Part I, the parts that are to follow will not give citizens an unbiased report such as they have a right to expect from a government-financed study. In his letter of transmittal the director, N. R. Danielian, says "This brief survey of the history of the St. Lawrence project indicates that the overwhelming weight of opinion, based on evidence gathered during the course of 45 years, has been in favor of proceeding with the construction of the St. Lawrence seaway and power project." Opinion in the U. S. Senate never has been overwhelming enough to get favorable action on a treaty approving the project.

JOHN L. CAMPBELL, former chief engineer of the El Paso and Southwestern Ry. and assistant chief engineer of the Southern Pacific, sent his many friends a unique greeting during the Christmas season in the form of a small pamphlet containing a brief but remarkably well written autobiography. Most of Mr. Campbell's mature life before his retirement was spent in the Southwest, chiefly in and around El Paso, Texas. His career was a cross-section of the engineering of that part of the country, county surveyor, city engineer, irrigation engineer, locating engineer, construction engineer and finally chief engineer of the principal railroad of the region. Looking backward, Mr. Campbell says "Advancement is largely a result of being, in place and time, ready and adequate for opportunity."

DEVELOPMENT of a convenient and reliable means for the design of any line of cast-iron pipe subjected to both external load and internal pressure has resulted from tests carried out at the Engineering Experiment Station of the Iowa State College. As described by W. J. Schlick, research professor of civil engineering, in Bulletin 146 this investigation had two main results: (1) determination of an empirical relationship for the combination of load and pressure, or the condition under which the pipe will fail; the method may be used to determine the class or thickness of pipe required for any combination of load and pressure; (2) determination of the safe design values of the strength ratios (ratios of field supporting strengths to three-edge support strengths) for pipe laid under different field conditions.

ENGINEERS looking for a quick graphic survey of New York City's stock of bridges, buildings and sewage treatment plants will find it in the 1939 report of the city's Department of Public Works. Commissioner I. V. A. Huie is in responsible charge of some $350,000,000 worth of property, and directs annual construction operations reaching $35,000,000. The year's operations and the current status of the property are well set forth, with excellent illustrations. Some valuable structure and traffic statistics are tabulated.

WELDING RESEARCH now in progress and results of the past year's activities are summarized in a pamphlet of the Welding Research Committee, 29 West 39th St., New York, forming the December 1940 Supplement to the Journal of the American Welding Society. The entire research program is operating on a budget exceeding $100,000 per year. Among the past year's results reported is a study of spot welding, contact resistance, inspection, effect of controlled atmospheres, and metallurgical effect of oxygen cutting. Reports of the Industrial Research Division covered weld hardening, weldability, and fatigue strength of welded joints.

MORE COMPLETE DATA on flow of the Rio Grande and use of its waters are given in the 1939 Water Bulletin of the International Boundary Commission than in the preceding annual issues. The bulletin will be found to be a fundamental document in any study of the complicated questions of international water rights and use on the Mexican boundary river.

A MASTER PLAN FOR FORT LEE (N. J.), a sample procedure for rehabilitation of a community, has been prepared by the Regional Plan Association, 400 Madison Ave., New York, as a demonstration of the type of treatment that can be applied to a community in financial difficulties. It is published as No. 53 of the Regional Plan bulletins. Price 25c.

New Engineering Books

HANDBOOK OF FIRE PROTECTION—Crosby-Fiske-Forster. 9th Edition. 1308 pp. Published by the National Fire Protection Association, 60 Batterymarch St., Boston, Mass. Price 4.50.

THE WHEELER PROJECT—Technical Report No. 2. 362 pp. Prepared by the Tennessee Valley Authority. Copies may be obtained from the Supt. of Documents, Washington, D. C. Price $1.

(Continued on p. 84)

A fast-cranking Exide Battery saves time with Diesel engines

Exide
BATTERIES
FOR CRANKING DIESEL ENGINES

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CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

SEWAGE DISPOSAL PLANT MITCHEL FIELD, L. I., N. Y.

OWNER: War Dept., U. S. Engineer Office, New York, N. Y.; Lt. Col. L. S. Dillon, district engineer.

PROJECT: Construction of sewage disposal plant and sewer line, and power line connections to existing lines at Mitchel Field, Hempstead, N. Y. Work involves construction of approximately 1,800 feet of sewer; furnishing and installation of underground power line; sewage pumping station and main operating building, including 1-story brick and steel superstructure; various concrete structures including grease removal tank, settling tanks, dosing tank, sludge digestion tanks, etc.; glass-covered sludge drying beds; natural sand filter beds; and miscellaneous sewage plant equipment.

CONDITIONS: Contractor to furnish all plant, labor and materials and complete work in 90 days after notice to proceed. Railroad and highway transportation facilities available at site of work. Minimum wage rates specified are: skilled labor, $1.25 to $2.12½ per hr.; semi-skilled, 86c. to $1.60; common labor, 81¼c.

BIDS: Fourteen bids were opened February 11, 1941, ranging from the contract low of $160,007 to $260,818. Engineer's estimate, $141,043. An alternate of Type A or Type B sludge collectors for settling tanks was allowed. Contract awarded on basis of former, and totals listed below are also on that basis.

LIST OF BIDDERS:

1. Gifford Constr. Co., Inc., Great Neck, L. I., N. Y. (contract) $160,007
2. Andrew Weston Co., Woodmere, N. Y. 164,155
3. A. J. Paretta Contract. Co., Inc., Long Island City, N. Y. 164,418
4. Kuchar Bros., Montvale, N. J. 167,074
5. Robert Young Constr. Co., Hartsdale, N. Y. 173,873
6. Suburban Engr. Co., New York, N. Y. 181,667
7. Auserehl & Son Contract. Corp., Jamaica, L. I., N. Y. 181,826
8. Zara Contracting Corp., Hewlett, N. Y. 189,661
9. Viking Constr. Corp., New York, N. Y. 189,913
10. M. D. Lundin Co., Inc., New York, N. Y. 191,146
11. John W. Ryan Constr. Co., Inc., New York, N. Y. 192,500
12. John L. Washbourne, Inc., New York, N. Y. 238,903
13. Cestone Bros., Inc., Verona, N. J. 246,654
14. Elmhurst Contract. Co., Inc., Corona, N. Y. 260,818

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Excavation, general	8,700 c. y.	$0.80	$1.00	$0.65
2. Excav., sand filter, sludg. dry. beds	41,000 c. y.	.40	.35	.33
3. Walks	100 s. y.	1.50	2.30	3.50
4. Roads	1,500 s. y.	1.50	2.30	3.20
5. Portland cement	1,400 bbl.	2.70	2.30	2.40
6. H. E. S. Portland cement	100 bbl.*	3.00	2.80	2.90
7. Class A concrete	1,065 c. y.	27.00	20.50	22.00
8. Class B concrete	65 c. y.	17.00	10.25	16.00
9. Steel reinforcement	117,000 lb.	.07	.06	.055
10. Brick masonry, manholes	40 c. y.	40.00	28.00	32.50
11. Brick masonry, waste gas burner	L. S.	200.00	150.00	260.00
12. Iron castings	1,500 lb.	.17	.20	.15
13. C. I. manhole fr., covers, gate boxes	9,700 lb.	.10	.09	.08
14. Misc. steel and wr. iron	11,000 lb.	.135	.14	.13
15. Aluminum gates and guides	275 lb.	1.35	1.50	1.30
16. Copper-silicon-manganese alloy	250 lb.	1.25	1.50	1.30
17. Floor grating	350 s. f.	2.00	2.00	1.54
18. Wr. iron pipe railings	200 l. f.	2.60	2.00	2.20
19. Int. c. i. pipe and fittings	9 ton	250.00	195.00	332.00
20. Ext. c. i. pipe and fittings, 6-in.	275 l. f.	1.40	1.85	2.10
21. Ext. c. i. pipe and fittings, 8-in.	340 l. f.	2.10	2.40	2.50
22. Ext. c. i. pipe and fittings, 10-in.	15 l. f.	5.00	3.25	5.27
23. Ext. c. i. pipe and fittings, 12-in.	50 l. f.	5.00	4.25	8.00
24. Ext. cast iron fittings	13 ton	200.00	190.00	285.00
25. Couplings, 4-in.	12 ea.	2.20	7.00	3.17
26. Couplings, 6-in.	10 ea.	3.10	9.00	4.09
27. Couplings, 8-in.	11 ea.	3.80	12.00	5.03
28. Couplings, 10-in.	5 ea.	5.40	14.00	7.32
29. Couplings, 12-in.	1 ea.	7.00	17.00	9.50
30. 2½-in. wr. iron pipe and fittings	950 l. f.	.66	1.00	1.06
31. 3-in. wr. iron pipe and fittings	750 l. f.	.40	.75	.62
32. 1½-in. wr. iron pipe and fittings	300 l. f.	.35	.50	.46
33. 1-in. wr. iron pipe and fittings	50 l. f.	.45	.40	.30
34. 2½-in. brass pipe and fittings	275 l. f.	1.50	1.60	3.68
35. 2-in. brass pipe and fittings	150 l. f.	1.30	1.30	2.32
36. 1½-in. brass pipe and fittings	25 l. f.	1.10	1.00	1.92
37. 1-in. brass pipe and fittings	20 l. f.	1.10	.80	1.10
38. ¾-in. brass pipe and fittings	25 l. f.	1.10	.60	.60
39. 2½-in. valves (all types)	12 ea.	11.00	12.00	15.00
40. 2-in. valves (all types)	12 ea.	7.00	8.00	6.00
41. 1½-in. valves (all types)	12 ea.	5.25	13.00	4.00
42. Valves (all types) 1-in. and under	12 ea.	3.25	3.20	2.30
43. 6-in. vit. tile pipe and fittings	125 l. f.	.45	.50	.75
44. 8-in. vit. tile pipe and fittings	750 l. f.	.70	.65	.85
45. 10-in. vit. tile pipe and fittings	425 l. f.	1.00	.85	1.25
46. 12-in. vit. tile pipe and fittings	675 l. f.	1.10	1.00	1.40
47. 15-in. vit. tile pipe and fittings	1,600 l. f.	1.75	1.45	2.20
48. 18-in. vit. tile pipe and fittings	3,300 l. f.	2.35	1.90	3.00
49. Water supply	L. S.	1,700.00	2,500.00	2,810.00
50. Sludge dry. beds and housing	L. S.	5,700.00	8,400.00	6,022.00
51. 10-in. vit. tile sect. cond. insulat.	75 l. f.	3.60	4.25	1.75
52. Pumping sta. superstructure	L. S.	8,700.00	9,100.00	7,328.00
53. Digest. control house, tank insulation	L. S.	3,000.00	3,200.00	2,447.00
54. Seeding	0.3 ac.	300.00	250.00	400.00
55. Screenings, comminutor	L. S.	2,300.00	2,600.00	2,100.00
56. Venturi meter	L. S.	1,300.00	1,250.00	900.00
57. Valves, 4-in. and larger	L. S.	3,000.00	3,500.00	3,000.00
58. Sewage pumps and meters	L. S.	3,500.00	3,000.00	2,000.00
59. Drain pump and meter	L. S.	100.00	150.00	125.00
60. Sludge pumps and meters	L. S.	1,700.00	2,000.00	1,600.00
61. Air blowers and meters	L. S.	800.00	1,200.00	400.00
62. Porous diffuser tubes	L. S.	130.00	100.00	160.00
63. Sludge collect., settling tanks (A)	L. S.	2,360.00	2,800.00	3,000.00
64. Sludge collect., settling tanks (B)	L. S.	2,740.00	3,000.00	2,600.00
65. Scum troughs	L. S.	675.00	650.00	450.00
66. Sludge digestion tank covers	L. S.	6,500.00	7,000.00	6,240.00
67. Waste gas burner	L. S.	125.00	125.00	120.00
68. Boiler room equip. and heating and gas system	L. S.	2,400.00	4,100.00	4,800.00
69. Alternating siphons, sand beds	L. S.	3,200.00	3,400.00	4,015.00
70. Chlorinator	L. S.	1,775.00	2,300.00	1,900.00
71. Laboratory equip.; accessories	L. S.	420.00	400.00	249.73
72. Electr. wiring and controls	L. S.	7,700.00	7,000.00	7,517.00
73. Main power feeder	4,050 l. f.	2.30	3.50	4.00

* Appears for canvass of bids only.

WHARF, CALIFORNIA

OWNER: U. S. Engineer Office, San Francisco, Calif.

PROJECT: Removal and disposal of existing torpedo wharf and boathouse, and construction of reinforced concrete abutment and wharf at Fort Scott, Calif. Wharf area 19,000 square feet.

CONDITIONS: Contractor to furnish all materials. Time for completion not yet determined; approval of award by Washington awaited. Rail, highway and water transportation facilities available. Wage rates prevailing are: skilled labor, $1.00 to $1.75 per hr.; semi-skilled, 70c. to $1.00; and common labor, 81¼c.

BIDS: Five bids were opened February 7, 1941, ranging from the contract low of $107,685 to $145,470. Engineer's estimate, $104,587.

LIST OF BIDDERS:

1. Heafey-Moore Co., and Frederickson & Watson Constr. Co., Oakland, Calif. (contract) $107,685
2. A. Soda & Son, Oakland, Calif. 108,732
3. Scheumann & Johnson, Eureka, Calif. 117,552
4. Healy-Tibbitts Constr. Co., San Francisco, Calif. 139,822
5. Duncanson-Harrelson Co., San Francisco, Calif. 145,470

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Remove exist. structures	L. S.	$2,400.00	$4,666.74	$3,000.00
2. Excav. and backfill	L. S.	2,700.00	2,500.00	2,000.00
3. Reinforcing steel	163,500 lb.	.05	.04	.05
4. Concrete	816 c. y.	24.00	22.00	33.00
5. Underdeck waterproofing	14,800 s. f.	.027	.07	.05
6. Furn. 20-in. precast conc. piles	6,688 l. f.	2.75	2.20	3.00
7. Furn. 18-in. precast conc. piles	2,369 l. f.	2.70	2.00	3.00
8. Struct. steel protector shoes	220 ea.	5.00	8.00	5.00
9. Drive conc. vertical piles	128 ea.	76.00	70.00	60.00
10. Drive conc. batter piles	92 ea.	82.00	90.00	90.00
11. Furnish fender piles	7,750 l. f.	.94	1.00	1.00
12. Drive fender piles	181 ea.	16.00	15.00	20.00
13. Pile stubs	1,500 l. f.	.60	.50	1.00
14. Floating log	38 l. f.	1.75	3.00	1.00
15. Treated timber	53.5 Mbm.	140.00	175.00	140.00
16. Hardware	21,500 lb.	.11	.15	.09
17. Miscellaneous steel	14,500 lb.	.16	.20	.13
18. Mooring bitts	6 ea.	110.00	125.00	120.00
19. Mooring cleats	8 ea.	60.00	100.00	75.00
20. Piping and supports	L. S.	3,000.00	4,000.00	3,500.00
21. Electrical installation	L. S.	1,500.00	2,000.00	1,500.00
22. Asphalt surfacing	18,300 s. f.	.128	.15	.15